SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1908.

GENERAL PHYSICS.

1552. *Testing of Glass Volumetric Apparatus.* **N. S. Osborne** and **B. H. Veazey.** (Bureau of Standards, Bull. 4. pp. 553–601, May, 1908.)—This paper deals with the testing of the accuracy of glass measuring flasks, measuring cylinders with or without subdivisions, transfer pipettes, burettes and measuring pipettes with partial or complete subdivisions, as carried out by the U.S. Bureau of Standards. General specifications are given, together with special requirements for the various types of vessel, rules for manipulation, tolerances allowed, &c. Tables are also given showing (1) the masses of volumes of water varying from 2,000 to 250 c.cm. at temperatures between 15° and 30° C.; (2) apparent weight in air of water; (3) temperature correction; (4) weight in gm. of 1 litre of dry air containing 0·04 per cent. of CO_2 at the temperatures 15–31° C., and pressures 720–775 mm. of mercury.

T. H. P.

1553. *Electric Controls for Pendulums.* **C. Féry.** (Journ. de Physique, 7. pp. 520–530, July, 1908. Paper read before the Soc. franç. de Physique, Jan., 1908.)—The problem was to keep up the energy of a pendulum, allowed to swing freely. Various methods are described and discussed. A new method is described, in which the pendulum does not touch any solid body during its oscillation. The pendulum carries a magnet which swings freely in a copper ring that forms the bob of an auxiliary pendulum of equal period with the principal pendulum. This auxiliary pendulum operates the contacts, of which there are two in each period—one to feed the sustaining bobbin, the other to actuate the clocks controlled by the principal pendulum. The auxiliary pendulum is actuated by the reactions between the free pole of the oscillating magnet and the currents induced thereby in the conducting annular bob of the auxiliary pendulum; and the principal pendulum is only subject to the friction of the air and to this magnetic damping, both of which are constant.

A. D.

1554. *Use of Micro-balance.* **O. Brill** and **C. de B. Evans.** (Chem. Soc., Journ. 93. pp. 1442–1446, July, 1908.)—The balance used was a modified and improved form of the Nernst quartz-fibre balance. It was possible to read to 0·02 of a division of the empirical scale corresponding with 0·004 mgm., appropriate corrections being made in the readings by means of a calibration curve. The amount of material necessary for the determination of atomic weight or density is reduced to a fraction of a mgm. The electrochemical equivalents of silver and copper were compared with a very satisfactory result, the weight of the copper deposited in a single experiment being from 0·5 to 1 mgm. The electrochemical equivalent of antimony was found to be 40·9. The balance can also be used for the measurement of the density of solids which can be obtained in regular form. The solid is first measured in all its dimensions and is then weighed; the advantages of this measurement over the methods ordinarily used are obvious in the case of rare, valuable, or chemically active substances. F. E. S.

1555. *Relation between Compressibilities, Thermal Expansions, Atomic Volumes, and Atomic Heats of the Metals.* **E. Grüneisen.** (Ann. d. Physik, 26. 2. pp. 393–402, June 9, 1908. Communicated from the Physikal.-Techn. Reichsanstalt.)—By developing Mie's theoretical considerations [Abstract No. 1450 (1904)], the author shows that, for metals which are monatomic in the solid state, $3av/KC_p$ should be constant, $3a$ representing the thermal expansion, v the volume of a gm.-atom, K the compressibility, and C_p the atomic heat at constant pressure. For 19 metals examined, the value of the above expression is approximately constant, deviations from the mean value being greatest for sodium, antimony, and bismuth. The results hence justify the assumption that the solid metals and mercury are monatomic. It is also calculated that iridium, the compressibility of which is unknown, is the least compressible of all metals and also possesses great hardness. For silicon and liquid chlorine the quotient $3av/K$ has the same value as for metals. [See also Abstracts Nos. 1138 (1907), and 879 (1908)]. T. H. P.

1556. *Longitudinal Impact of Metal Rods with rounded Ends.* **J. E. Sears.** (Cambridge Phil. Soc., Trans. 21. No. 2. pp. 49–105, Aug. 25, 1908.) —A complete discussion is now given, with experimental confirmation from several aspects in addition to that mentioned in Abstract No. 1988 (1907). By combining St. Venant's theory of wave propagation of stress with that of Hertz for the stress in the neighbourhood of contact of two solids, an approximate solution is obtained for the position in the rod where the end effect ceases to disturb appreciably the propagation according to St. Venant's formula, for which some justification is to be found in the agreement between the observed results and the calculations. The theory is extended to plane-ended rods by considering these as being built up of a number of round-ended hexagonal prisms. The curve relating duration of impact and length of one rod, the other rod remaining constant in length, consists of three, or possibly four branches. The first of these and part of the second were confirmed by the experiments. The branches join at points where the length of one rod is a multiple of that of the other. The increased duration of impact with low velocities was followed down to a velocity of 0·6 in. per sec. It is probable that the values become slightly too high at these velocities, owing to the relative importance of the non-homogeneity of the metal. The equality between the Young's modulus under static and instantaneous loading was mentioned in the Abstract referred to above. It is deduced that the values of all the elastic constants of a metal are the same under instantaneous as under steady stress, but there appears to be an implication that if an elastic time-effect be observed (as is recorded in the case of Al) then the measurement of strain upon which the calculation of the static modulus is founded is that taken immediately after loading. It is shown that, as pointed out by Hopkinson and Rogers in the case of hot metals [see Abstract No. 2072 (1905)], a certain part of the strain occurs instantaneously upon application of load, and is independent of the time-effect, if any. The calculated mean stress over the area of contact of the rods reached 72 tons per sq. in., and max. 108 tons per sq. in., without observable overstrain [compare Abstract No. 921 (1905)]. The general characteristics of extension under stress, when an elastic time-effect occurs will be represented by an equation of the form $\epsilon = Pl(1-be^{-kt})/E$, where ϵ is extension, P stress, l length of specimen, t time from application of load, and E, b, and k are constants of the material. E is the ordinary static value of Young's modulus, which includes time-effect; with $t=0$, the instantaneous value of the modulus is obtained, viz., $E/(1-b)$, or $E(1+b)$ since b is small $(=\frac{1}{100}$ for Al). Formulæ of the above type may be deduced from other hypotheses, of which one example consists in assuming the crystalline grains of a metal to be æolotropic, having a modulus E_1 in one direction, and E_2 in a perpendicular direction. **F. R.**

1557. *Cohesion of Steel, and Relation between Tension and Compression Yield-points.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 28. pp. 874–881, 1908.)—Assuming the existence of a resistance of the nature of friction opposed to slipping on planes in a bar of steel, it is readily deduced, since slipping occurs along the surface where the difference between the intensity of tangential stress and frictional resistance is greatest, that this happens at an inclination $\beta = 45^\circ - \phi/2$ to the axis when the bar is in compression, or $\alpha = 45^\circ + \phi/2$ when in tension. Here the coefficient of friction is $\mu = \tan\phi$. The author has found the usual value of α to be 50° [see Abstract No. 2017 (1905)] but β which should therefore be 40° has not been satisfactorily verified. Taking $\phi = 10^\circ$, $\mu = 0{\cdot}176$, which agrees fairly well with Morin's values for the friction of dry metals. Further it can be shown that the ratio of yield-points in tension and compression, $l/c = [\sqrt{(1+\mu^2)} - \mu]/[\sqrt{(1+\mu^2)} + \mu] = (1-\mu)/(1+\mu)$ approximately, since $\sin\phi = \tan\phi$ nearly. Hence the value of l/c is about 0·705. Values of t/c obtained for $\frac{3}{4}$-in. diam. mild steel bar averaged 0·98. and for 8 in. by $\frac{3}{8}$ in. plate 0·804. On the hypothesis that there exists a cohesion of amount K, in the same units as the stresses, acting between the molecules, it can be proved that $K = c[\sqrt{(1+\mu^2)} - \mu]/2\mu = t[\sqrt{(1+\mu^2)} + \mu]/2\mu$. For steel taking as before $\phi = 10^\circ$, we obtain $K = 2{\cdot}884c = 8{\cdot}884t$. A number of values of K deduced from observations of t are compared with the observed stress at rupture (final load ÷ contracted area). The values of K range from 44·0 to 77·9, and of the stress at rupture from 41·6 to 65·5. On the whole there is reasonably good agreement, the breaking stress being rather lower than K usually. **F. R.**

1558. *Relation between Tensile and Shock Test Results.* **O. Thallner.** (Stahl u. Eisen, 28. pp. 1081–1088, July 29; 1167–1174, Aug. 12, and pp. 1209–1215, Aug. 19, 1908.)—The variation of tensile strength with length of specimen is studied, the length being reduced until a round notched and finally a sharp V-notched specimen are reached, whose breaking loads are much higher than those of the usual specimens, as is well known. Experiments in which various steels were tested by shock bending, led to the need of knowing the energy absorbed up to the moment at which fracture begins. This was studied by giving repeated blows of increasing energy to V-notched specimens of various depths. The conclusions are that the energy absorbed up to the commencement of breaking is dependent on the depth of specimen; the specific resistance to shock increases with the depth or the area of cross-section in a different manner for different metals. The ratio of the energy absorbed up to the commencement of fracture to total energy required for fracture is different for the different kinds of steel. Comparative static bending tests of notched specimens are also given. The principal generalisations from this series of tests refer to the type of fracture. Whatever type of fracture is found in the static test, there is a tendency to a more crystalline fracture in the shock test. If a cup-and-cone fracture is found in the static test without any crystalline surface, the fracture of the shock-test piece will be similar, but may or may not be crystalline; in this case the energy absorbed is always high. Series of static and shock bending tests with notches of different forms are also described. "Velocity" is only dealt with from the point of view of the effect of variation of depth of section of the shock-test piece. It is argued that increase of "velocity" will raise the max. load during fracture, hence the load-deflection diagram will vary for different velocities in a similar manner for mild, hard, or tough steel, the ratio of the energy absorbed before the max. load is reached to the portion after being greater, the greater the depth of the specimen. F. R.

1559. *Torsion of Angle-Iron.* **F. Kötter.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 39. pp. 935–955, 1908.)—Gives a complete mathematical analysis, the following formula being arrived at: $M = M' + 2GTd^4C$, where M' is the value of the torsional moment for a rectangle of sides $l_1 + l_2$ and d respectively, viz., $M' = \frac{1}{3}TG(l_1 + l_2 - 0{\cdot}63d)d^3$. Here G is the shear modulus, C is the value of the torsional moment for unit width $(d = 1)$ and unit angle of torsion $(T = 1$ per unit length). l_1 and l_2 are the lengths of the arms of the angle-iron, measured from the intersection of the centre lines of the arms. The angle-iron is considered as two rectangles without any rounded corners. F. R.

1560. *Factor of Safety in Marine Engineering.* **J. O. Arnold.** (Inst. Naval Architects, Trans. 50. pp. 260–282; Discussion, pp. 283–289, 1908. Engineering, 85. pp. 565–566; Discussion, pp. 543 and 545, April 24, and pp. 598–601, May 1, 1908.)—The factor of safety, based as is usual on ultimate strength, is uncertain, as it may give a working stress quite close to the elastic limit. No definite proposals are made, however. The results given by the author's alternating bending machine have mostly appeared in previous papers [see Abstract No. 2128 (1905)]. Cold-drawn bolt steel does not endure the test so well as simply hot rolled steel, and longitudinal test-pieces from shafts are more enduring than transverse samples. F. R.

1561. *Modern Armour and its Attack.* **T. J. Tresidder.** (Inst. Naval Architects, Trans. 50. pp. 25–46; Discussion and Correspondence, pp. 47–58, 1908. Engineering, 85. pp. 484–487, April 10, 1908.)—A discussion of the action taking place between projectile and armour. There are three critical velocities of the projectile: (1) That which gives higher initial compressive stress than the uncapped point can bear; (2) the minimum which enables the cap to reinforce the point to such an extent that it can bear the high initial stress without fracture; (3) the minimum which enables the uncapped point again to bear without fracture the stress to which it is subjected. (1) and (2) may sometimes coincide. That (3) probably exists is illustrated by the familiar experiment of shooting a candle undeformed through a board, which the author repeated. In practice, (3) is very high. It is probable that failure of an A.P. shell frequently occurs by a very small piece of the point being forced back into, and so splitting, the shell. A larger piece is then similarly forced back, and so on. Hence the author considers the main advantage of the cap is to support the shell against this splitting. Incidentally the stress intensities in both plate and projectile are increased, and no serious preparatory work is done by the cap at ordinary striking velocities. Caps of the usual form have too small a diam. to reinforce adequately the shell against stresses relatively slowly applied. It is considered that with greater diam. the inefficiency of caps at low velocities would be reduced. The effect of oblique impact is discussed, with special reference to the case in which the axis of the projectile is, on account of gyrostatic action, inclined to the trajectory by an amount which increases with the range. This introduces a cross-breaking effect upon the projectile. F. R.

1562. *Breaking of a Wire Rope.* **E. Heyn and O. Bauer.** (Stahl u. Eisen, 28. pp. 1240–1242, Aug. 26, 1908.)—Contains a report on the examination of a wire colliery rope, broken during use and thought to have been caused by criminal interference. The wires obtained from positions away from the break were tested and gave good tensile and extension tests. The broken ends of the individual strands showed the following characteristics: (1) Some parts of the wire seemed to have been cut by the lacing over of other wires; (2) breaking partly occurred without any dent appearing at the breaking-point; (3) on many places, both in the neighbourhood of the break and at larger distances, dents running out in a spiral form were to be seen; (4) round impressions were seen; (5) many ends of wires showed marked alterations in the shape of the diagonal section; (6) partly, the round wire became flat, square, or angular. Points where chisel, file, &c., had touched were not to be seen, showing that the break had no criminal origin, and the alteration in the shape of the wires showed that the rope had mechanically given out, having been damaged by too strong a pull. C. O. B.

1563. *Tests of Reinforced Concrete Bridge Slabs.* (Eng. News, 60. pp. 145–148, Aug. 6, 1908.)—Reinforced concrete bridges which are being used on the Illinois Central Railroad in Chicago are described in detail. A report by A. N. Talbot is also given, which describes tests made upon complete beam or slab members weighing 33 tons each, having a span of 25 ft., width 6 ft. 3 in., depth at centre 34 in., and 1·25 per cent. of 1-in. corrugated bars as reinforcement. Loaded at the 1/3 points the beams failed at total loads of from 800,000 to 840,000 lbs., and are stated to have behaved as well as laboratory-made beams are usually found to do. One beam had no reinforcement in the form of stirrups; but the others had rectangular transverse hoops and in these the longitudinal bars were bent up more gradually than in the other. The stirrups are considered advantageous, and the slighter obliquity of reinforcement diminishes the tendency to failure by "diagonal tension"; these beams withstood the higher loads mentioned. The report includes measurements of deflections during testing, and notes on the appearance and progress of cracking. F. R.

1564. *Ship-model Experiments.* **H. Wellenkamp.** (Inst. Naval Architects, Trans. 50. pp. 225–234; Discussion and Correspondence, pp. 234–241, 1908. Engineering, 85. pp. 562–564; Discussion, p. 542, April 24, 1908.)—This paper gives a description of a new method of research work on fluid resistance and ship propulsion. The object aimed at in the experiments was to apply a constant tractive power exactly equal to the resistance the model experiences at a given constant speed, the initial accelerated portion of the motion being produced by means of an additional starting weight (considerably greater than the towing weight), in the form of a chain whose action decreases from the full extent of its weight down to zero at the end of the starting run. The towing weight is attached to the end of the long bowsprit of the model by a very thin piano-wire, which passes over a drum of circumference 1 m., whose surface is blackened to receive the wavy trace of a style on the end of a large tuning-fork. The fork has a slight horizontal traverse, so that the fork trace goes spirally round the drum, and measurements along the mean line serve to give the velocity of the model. Should the velocity not be constant during the trial run a simple calculation shows what weight has to be added to or subtracted from the towing weight to secure constant velocity. A device consisting of a supplementary wire of double the linear density of the towing wire serves to keep the towing force exactly constant. Owing to the reduction of the starting run, a tank can be used very much shorter than is ordinarily the case in ship-model experiments; and no engine gear is necessary, with the expensive foundations for the rails. A. W.

1565. *Wind-pressure.* **T. E. Stanton.** (Inst. Civil Engin., Proc. 171. pp. 175–200; Discussion and Correspondence, pp. 201–226, 1907–1908. Communicated from the National Physical Laboratory.)—The experiments described form the second part of the research on the distribution and intensity of the pressure of the wind on structures [see Abstract No. 2444B (1904)]. The present researches were made on flat surfaces, of areas ranging up to 100 sq. ft., when exposed to the wind, instead of an artificial current of air. The main object was to determine the cause of the difference between the pressures on large plates and small plates discovered by B. Baker at the Forth Bridge in 1884. The author finds that the lower pressure on the large surfaces is not a dimensional effect, but an effect due to the structure of the wind, whose gusts are more effective on a small area. The effective pressure of wind on a girder or other structure may be determined from that on a small model by multiplying by the square of the ratio of linear dimensions. In the *discussion*, **C. Chree** pointed out that the velocities were determined from observed pressures. This is only legitimate when the density is constant. **Shaw** drew attention to the importance of the fact that the resistance offered by a structure to the wind in the open air was 18 to 20 per cent. higher than the resistance offered by the same structure to a steady artificial current. **Dines** mentioned having found that the resistance of balloons varied as the square of their diam., by means of theodolite observations. **Shelford** was not convinced that the ratio between pressure and velocity remained constant at speeds above 80 miles an hour. E. E. F.

1566. *Determination of Viscosity at High Temperatures.* **C. E. Fawsitt.** (Roy. Soc., Proc. Ser. A. 80. pp. 290–298, April 6, 1908.)—The method used consisted in causing a horizontal disc to oscillate in its own plane when immersed in different liquids and measuring the logarithmic decrement. As the method was intended for use with fused salts and metals it was necessary to weight the disc by applying a load above the surface of the liquid. Experiments with water, chloroform, mercury, benzene, and ethyl alcohol at 20°, with mercury at temperatures from 65° to 216°, and with sodium nitrate from

820° to 450° gave results in good agreement with those of previous observers using the capillary tube method. As a fireclay or graphite disc will remain uncorroded at temperatures up to 1,000° the method appears to be well suited for experiments on liquids of moderate viscosity at temperatures considerably higher than those which have previously been used in work of this kind. [Additional data obtained are given in Chem. Soc., Journ. 93. pp. 1004–1005, June, 1908.] T. M. L.

1567. *Essential Meaning of d'Alembert's Principle.* **F. Slate.** (Science, 28. pp. 154–157, July 31, 1908.)—The author states Newton's second law of motion in the form—

$$\sum_0^x (\Delta X)_x = \sum_0^m (\Delta m\ddot{x}) \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

and compares it with d'Alembert's principle, as stating that the "lost forces" form a system in equilibrium. This may be expressed for a single mass *m* in the form $P = R + m\ddot{x}$, or $P - R = m\ddot{x}$. In the first of these forms it expresses the fact that the forces P overcome the resistances R, and produce acceleration as well. In the second form it puts to the front the idea that the total force P − R sets up static stress ± R to an extent determined by the resistances, the remainder becoming effective as a volume distribution of force producing local accelerations. Separating the arbitrary external forces A, from those determined by the conditions of the system, S, the equation takes the form $A = S + m\ddot{x}$, which he says is convenient for mathematical purposes. Also writing equation (1) in the form—

$$\sum_0^x (\Delta X)_x - \sum_0^m (\Delta m\ddot{x}) = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

he says that if this is regarded merely as a transposition of (1) [which surely it is], the second sum cannot represent forces actually applied to *m*, because such ought to be included in the first term. Neither, he says, can it be regarded as an equilibrium equation *m* so long as the second sum does not vanish. This may appear at first sight inconsistent with "clear thinking," but the conclusion is best given in the author's own words. "d'Alembert detected in $-\sum_0^m \Delta m\ddot{x}$ a new sense by associating it with other force terms as their equilibrant; or following a more modern tendency, that sum, again recognised as force, is regarded as due to reactions of *m* upon bodies that transmit forces to it. It is clear that neither view preserves the scheme of equation (1). The first uses the real equilibrium condition of (7) in order to exhibit the actual departure from it. The second includes forces acting, not on *m*, but on surrounding bodies." S. H. B.

1568. *Theory of Capillarity.* **E. T. Whittaker.** (Roy. Soc., Proc. Ser. A. 81. pp. 21–25, July 30, 1908.)—The relation between the surface tension γ and the surface energy λ at absolute temperature T is given by $\gamma = \lambda + T d\gamma/dT$. Taking the value of λ over wide ranges of temperatures, as given by the determinations of Ramsay and Shields for the non-associating substances ethyl oxide, methyl formate, carbon tetrachloride, benzene and chlorobenzene, the empirical relation is found that the surface energy of a liquid in contact with its own vapour at any temperature is proportional to the product of the internal latent heat Λ and the absolute temperature, or $\lambda = \text{constant} \times T\Lambda$. Tables are given for the five substances showing the consistency of the relation. G. E. A.

1569. *Temperature Fluctuation of One Day's Period in the Wolfgangsee.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 9–26, Jan., 1908.)—The author conducted measurements, with which he is himself not satisfied, in the rainy July of 1907. His electric thermometers were of the A. Kreidl type made by Haack, of Vienna; the glass bulb and capillary contain a carbon thread dipping into mercury. The thermometers had not been sufficiently tested, and the insulation of the leads, placed on poles and trees, was faulty. The six thermometers were floated about 40 m. from the bank in 40 m. of water, at depths of 0·65, 1·9, 4·07, 7·24, 12·2, 21·12 m., and readings were taken every 8 hours. There are indications of a temperature seiche, which the author explains rather on E. R. Watson's lines (a stationary low-level wave) than upon Wedderburn's lines (wind currents) [compare Abstracts Nos. 588 (1907) and 567 (1908)]; he believes, however, in a discontinuity layer.

H. B.

1570. *Meteorological Elements of the United States and Solar Radiation.* **F. H. Bigelow.** (Amer. Journ. Sci. 25. pp. 413–430, May, 1908. Paper read before the Philosoph. Soc., Washington, Feb. 1, 1908.)—The temperatures of the United States are more the product of heat which is transported in the general circulation than of direct solar radiation. An increase in solar radiation will increase the heat energy and temperature of the tropics; but this will be followed by a decrease in the temperature of the middle latitudes, because the return currents from the polar zones transport an excess of cold air towards the tropics over the temperate zones which is to compensate for the increase of warm air transported in the upper levels towards the poles. This applies particularly to the United States, where the influences of circulation are registered in the prevailing powerful cyclonic action. In order to separate circulation from solar radiation the author examines the records from 50 (out of the 100) stations of the U.S.; he divides these into 10 groups of 5 stations and unites them into the three chief groups of the Pacific States, Plateau and West Gulf States, and Central and Eastern States. He also inquires into the relation between solar prominences and European magnetic horizontal force, and studies their synchronism with the temperature and vapour and barometric pressures of the U.S. in the 11-year and the 3-year periods. The synchronism is better defined in the Pacific States than east of the Rocky Mountains, especially in the short period. The amplitudes of the three elements (curves of temperature, barometer, vapour pressure) increase from S. to N. In the long-period curves an increase in the prominence and magnetic-force numbers is always accompanied by a decrease in temperature and vapour pressure, but by an increase in the barometric pressure; in the short period the same rule holds for the east, but the reverse for the Pacific States, whose temperatures generally are the reverse of the central and eastern districts in the sense that the monthly residuals have opposite signs. This is explained by the circulation. The Pacific States may practically be considered as part of the tropical system, characterised by a quiescent state of the atmosphere and freedom from cyclonic circulation; part of the Rocky Mountains cyclones and high-pressure areas advance down the slope eastward.

H. B.

1571. *The Isothermal Layer of the Atmosphere.* **C. Chree.** (Nature, 78. p. 298, July 30, 1908.)—The author had suggested [Abstract No. 719 (1908)] that ballons sondes should be fitted with instruments of different types in order to test the reliability of these instruments. Hergesell and others have meanwhile done this. With thermographs of his own and of Teisserenc de Bort's, discrepancies amounting to several degrees Centigrade have been found on the simultaneous records, both at Strassburg and at Uccle; the discrepancies were more marked during descent than during ascent, and the isothermal layer was sometimes distinct, sometimes not. H. B.

1572. *Cloudiness Statistics.* **A. v. Obermayer.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 217–229, Feb., 1908.)—Cloudiness is generally estimated in tenths of the covered sky area. The records frequently indicate a certain preference of the observer for certain numbers. Thus the St. Gotthard cloudiness statistics for 1906 contain the number 4 in 81 cases, 100 times the number 5, 14 times the number 6, and 102 times the number 7. Examining the records for 18 high- and low-level stations, the author finds evidence of individual preference in the Sonnblick statistics, where several observers succeeded one another; the Ben Nevis records appear very reliable. The author then investigates how the tables of cloudiness-numbers are connected with the actual degrees of cloudiness. For the deduction of curves he considers the theory of collective objects, as developed by H. Bruns, G. Lipps and E. Czuber more suitable than K. Pearson's theory of evolution. H. B.

1573. *The First Morning Twilight and the Second Evening Twilight.* **E. Durand-Gréville.** (Comptes Rendus, 147. pp. 818–820, Aug. 8, 1908.)—For more than a century certain twilight phenomena have been observed which never occur during the quarter-hour preceding sunrise or following sunset. Such are: the recolouration of the Alps after sunset; the diverging rays seen at twilight streaming from the west or east; the purple glows in the east or west; the glows following volcanic eruptions; the "second ray" seen in Syria, Egypt, India, &c. The author believes he has discovered a single explanation covering all these phenomena. The first observations to the point were made at Banyuls (Pyrénées-Orientales), in Feb., 1896. Directly the sun disappeared behind the Pyrenees, the grey-blue shadow of the earth was projected on the mists overhanging the sea horizon in the east. More than half an hour later, there appeared below the dark band a light band, followed later by a second dark band. This lower dark band gradually widened, overtaking the other two. Since then the author has observed the same phenomenon in level country, and in all latitudes between Rome and Stockholm, the only difference being that the light band appears earlier on the plains than in the mountains. Arctowsky has seen the two first bands under the Arctic Circle, the sun not sinking low enough below the horizon to render the third band visible. These observations show that the phenomenon of the recolouration of the Alps after sunset is only one manifestation of a general phenomenon, rendered more striking by local conditions. The explanation by an incurving of the solar rays due to the chilled air in the valleys must therefore be rejected. The author states that it is necessary to admit the permanent existence of a luminous conoïd within the cone of the earth's shadow. The cause, he adds, is no doubt to be sought in the layer of inversion of temperature which Teisserenc de Bort has shown to exist in the atmosphere at an altitude of 12 to 14 km. The luminosity in question never descends to the earth's surface, the observations giving 1,600 m. as the minimum approach. Similar phenomena to the above also occur in the morning before dawn, but the observations are less numerous. The evening observations were made upon clouds as well as mists, namely cirrus at 9 km. altitude, and cumulus sometimes higher than Mont Blanc. Some 15 or 20 min. after sunset the cirrus near the eastern horizon becomes reilluminated, and then the other clouds also become visible again successively from east to west, this second illumination being followed by a second extinction. On July 17, 1898, at Angers, 48 min. after sunset, the author observed rosy rays crossing the zenith and converging towards the east and west. The point of convergence to the west was at least 8° above the sun—a fact which, he remarks, affords proof of the refraction of the solar rays penetrating the shadow cone. A. E.

1574. *Search for a Particular Class of Rays which may be emitted by the Sun.* **H. Deslandres.** (Comptes Rendus, 147. pp. 873–875, Aug. 17, 1908.) —From his observations of the phenomenon of second twilight, Durand-Gréville infers the existence of a luminous conoïd which penetrates into the interior of the earth's shadow-cone, and reilluminates the eastern part of the sky 15 or 20 min. after sunset [see preceding Abstract]. Apparently he ascribes the phenomenon to reflection of the solar rays by the higher strata of the atmosphere, since he indicates as its possible origin the layer of temperature inversion discovered by Teisserenc de Bort. While admitting the probability of this explanation, the author suggests another. The solar radiation as observed at the surface of the earth extends from about wave-length 10 μ to 0·3 μ. These limits are imposed by the absorption of water-vapour on one side, and of permanent gases on the other. But there is no reason why these absorption bands should extend indefinitely; on the ultra-violet side, for instance, the atmosphere may become transparent again at a certain distance from 0·3 μ. According to Schumann, the ultra-violet absorption band extends at least to 0·1 μ, but beyond this limit there may be rays which are capable of traversing our atmosphere. It is further possible that these rays may have a much greater index of refraction than the known rays. At the edges of an absorption band anomalous dispersion, accompanied by large differences of index, is to be expected. If the ratio $(n-1)/d$, where n is the index and d the density of the gas, is 5 or 6 times as great as for the visual rays, sunset would take place about 15 min. after sunset observed with the eye. If, again, it be assumed that these rays excite phosphorescence of atmospheric particles, a not unnatural supposition in the case of ultra-violet rays, then the phenomenon of second twilight can be explained by their intervention. The author suggests a method by which search might be made for the supposed new rays, and other similar rays, adding that the search would already have been undertaken at Meudon if the staff and budget had been sufficient. The earth's atmosphere acts upon the sun's rays like a prism with angle increasing with the sun's zenith distance; it deviates them unequally, and may separate them. Here, then, is a natural prism directly adapted for the search after unknown solar rays having an index noticeably greater or less than the known rays. The research apparatus should be movable in a vertical plane passing through the sun and should be provided with at least a rough azimuthal circle in order that it may be kept in this plane even when the sun has set for our eyes. The equipment should comprise all the known means for detection of invisible radiations: such as photographic plates, phosphorescent substances, and instruments for measuring the conductibility of the air and the discharge of electrified bodies. The observations would be made on a mountain or even from a balloon. Since the phenomenon of the second twilight is only visible above 1,600 m., an elevation of 2,000 m. would be advisable for a first study. At sunset (or sunrise) the rays sought for might then, during a few minutes, be separated from the ordinary rays, and only interfered with by diffuse sky-light. Once discovered, perhaps there is hope that the rays may exhibit some property which would enable them to be isolated in full daylight, and thereafter studied at leisure. A. E.

1575. *A Hailstorm following the Course of an Electric Transmission-line.* **J. Violle.** (Comptes Rendus, 147. pp. 875–877, Aug. 17, 1908.)—The author quotes a letter received from a colleague, M. Fagniez, of Chateau de la Bonde, Vaucluse, describing a hailstorm which occurred there on June 26, about 5.30 p.m., under peculiar circumstances. The storm swept over an area about 14 km. in length and 2 km. in breadth. Its direction corresponded to that of a 45,000-volt three-phase transmission-line which has been operating for under a year. The line is roughly parallel to a chain of mountains 1,000 to 1,100 m. in height, called the Luberon, which has a reputation for attracting hail, is at an altitude of from 200 to 400 m., and is situated from 8 to 5 km. south of the Lubéron. A number of narrow valleys run down from the chain and are cut at right angles by the line. It was observed that the storm, on encountering, at its start, one of these valleys, at first followed it towards the Lubéron, then crossed it at a point where the bank dipped, rejoined the course of the electric line, which it had not completely deserted, and thence followed the latter closely till the hail stopped. The effects of the storm were felt most strongly in the immediate vicinity of the line, decreasing gradually on either side. At the centre of the stricken zone, along the trace and following the contours of the electric cables, the hail fell without rain during nearly a quarter of an hour, while at the two sides it was accompanied by water. Storms in this region generally come in the opposite direction to that which this one took, and without bringing hail. The author suggests that the observations indicate that the action of the current had some effect in attracting and directing the storm. A landowner, who was 400 m. from the cables in the region where the storm began, reported having seen near the cables three great balls twice the size of a man's head, which remained suspended for a moment, and then exploded immediately before the fall of hail. The author remarks that while there is little doubt that the transmission-line conducted the storm, whether it attracted it is more questionable. A. E.

1576. *Searching for Underground Sounds with the Daguin Acoustèle.* **F. Diénert, A. Guillerd, and Marrec.** (Comptes Rendus, 146. pp. 1182–1184, June 1, 1908.)—The acoustèle is a cornet, in the lower portion of the interior of which a solid cone is fixed which turns its base to the narrow part of the horn. A hole of about 80 cm. depth is made in the ground; the instrument is inserted into it, and the observer listens at the mouth. The sound of water flowing underground resembles the noise made by the wind in a forest. Subterranean waterfalls can be heard at distances of 60 m. The instrument is more useful than the microphone, but perhaps not much more reliable than the diviner's rod. H. B.

1577. *Evaporation Observations on the Reno Reservoir, Nevada, Aug. 1 to Sept. 15, 1908.* II. and III. **F. H. Bigelow.** (Monthly Weather Rev. 36. pp. 24–39, Feb., 1908. Paper read before the Philosoph. Soc., Washington, March 14, 1908.)—Preliminary account of some 85,000 observations, involving about 100,000 readings, taken at the Reno Reservoir, which is really a double reservoir, supplying the towns of Reno and Sparks with water from the Tahoe Lake, level 6,200 ft., east of the Sierra Nevada. The reservoir level is 4,000 ft. The plain is sheltered; the weather is calm till 10 a.m., when a wind from S.E. springs up which turns to the W., and increases in velocity up to 80 or 40 km. per hour in the afternoon. Five towers have been erected, all in a straight line E. to W., three on the reservoir walls, two outside in the field, all 45 ft. in height, but one on lower level than the others. On these towers, and further on the ground and the water itself, are placed 29 pans for evaporation tests; three pans are floating on the water, which has proved a troublesome disposition. Six improved Piche evaporimeters were also used; in high winds the evaporation from the edge of the filter paper is quicker than the supply of water from the feeding tube to the edge, a distance of 8 cm. The evaporation from the paper is 1·177 times faster than from free water, per unit surface of 1 cm.^{2}. The location of the pans relative to the water of a reservoir is of primary importance for the amount of evaporation. The paper tabulates the observations and discusses them. Recording instruments are needed. [Compare Abstract No. 19 (1908).] H. B.

1578. *The Advance of the Tidal Wave in the Adriatic.* **R. v. Sterneck.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 151–208, Jan., 1908.)—Our knowledge of the tidal phenomena in the Adriatic Sea was based chiefly on the publications of the Adria Commission of 1869–1870, when the establishments for 6 ports—Triest, Pola, Fiume, Zara, Lesina, and Corfu—were determined. By interpolation the time equations were fixed for other ports, and the author deduced, some years ago, from those figures the probable isorachies (lines of equal establishment) for the Adriatic. When the Militär Geographisches Institut put up tidal gauges at Rogožnica and Sestrice, however, mistakes were discovered in the interpolater figures. The author has hence determined the establishments of 26 ports of Dalmatia and the other coasts; his son Robert has made three determinations on the Italian coast, and 6 stations have been investigated by the just-mentioned institute, so that reliable data were at his disposal for 88 stations. The paper describes the tide gauges (of the ordinary type) and his method of reducing the records. The conclusions are the following: As regards the tides the Adriatic may be divided into a southern portion (south of the line Monte Gargano–Ragusa), little explored, but apparently connected with the tides of the Ionian Sea, and a northern portion, to which the author confines himself. The port establishment (*i.e.*, the difference between high or low tide and the upper (or lower) transit of the moon) sets in with the value 4 hours, increases as the wave advances, first northward along the Austrian coast and then southward along the Italian shore, and reaches Ancona with the value 12 hours or 0. The velocity of the wave varies greatly from 800 km. in the south to 25 km., near Sestrice and Punte Bianche (district of Zara). The wave may be regarded as an oscillation of 12·4 hours' period about two nodal lines with a phase-difference of 2 hours, intersecting at right angles near Arcona, about 50 km. east and 20 km. north of it. The shallow channels near Zara retard the waves and cause the tide to enter from both sides. The amplitude of the wave ranges from 19 cm. about the middle of both coasts to 88 and 98 near the head of the Adriatic; the mean is 29 cm. The daily inequality is so marked in some parts that one of the tides may almost be suppressed. H. B.

1579. *The Calabrian Earthquake of Oct. 23, 1907.* **G. Mercalli.** (Comptes Rendus, 147. pp. 283–286, July 27, 1908.)—The Calabrian earthquake of Sept. 8, 1905 [see Abstract No. 384 (1907)] was succeeded by 324 after-shocks till July 31, 1907. Then followed a calm, till the new earthquake took place, which did not affect quite the same district, however. After five preliminary shocks on Oct. 23 came a stronger shock at 9.29 p.m., and then the disastrous concussion at 9.32, lasting 10 or 12 sec. According to the author's studies in April, 1908, the epicentral area seems to have been very restricted, only a few sq. km. The destructive waves were confined to the Ionian slope of the Aspromonte ; the weaker waves travelled further to the Tyrrhenian slope of the Apennines. The great lithological heterogeneity of the district explains some of the peculiarities of the destruction ; 158 people out of 1,967 inhabitants perished. H. B.

1580. *Seismic Records obtained at Göttingen in* **1906. K. Zoeppritz.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 129–190, 1908.)—The observations have been carried on by Angenheister and the author, as in the three previous years. The constants have been well maintained, the period of the vertical instrument decreased from 5 to 3·7 sec., however, in the course of the year, as the small springs had not been properly tempered. The paper is mainly tabular, but discusses the microseismic movements at some length. In these O. Hecker distinguishes four groups, whose periods are 4 sec. maximum, about 7 sec., 30 sec., and one of several minutes. The first oscillations are very feeble, as the station is fortunately situated ; only the 17-ton pendulum (with magnification of 2,000) records the vibrations of the gas engines in the Göttingen electricity works, 2·5 km. distant, yielding as a rule a regular sine curve of 180 periods per min. and marking beats when several motors run at different periods. The third (30-sec.) movements which Hecker ascribes to the position of the atmosphere on the earth's surface are also weak. Particular attention is drawn to the movements of the second group (period about 7 sec.), which are generally regarded as meteorological. These microseismic fluctuations are weak when there is a uniform barometer all over Europe, including the north ; when a depression approaches from the Atlantic, the movements become pronounced. The immediate cause of the oscillations is not clear, however ; it might directly be the pressure-differences (Hecker), although we do not understand how that could call forth periodical oscillations in the earth ; or the local gradients and winds (not likely, according to Hecker and the author), or the waves breaking on the shores. The author inclines with E. Wiechert to the latter view. He has examined the records concerning the state of the sea from 28 stations on the Atlantic, the Channel, North Sea and East Sea, in France, the United Kingdom, the Netherlands, Germany and Norway. Unfortunately, the state of the sea is as a rule estimated only once a day in a rather arbitrary manner ; he finds a good agreement, however, between his observations and the reports from Norway for the first two April weeks of 1906, and he tries to allow also for the direction in which the breakers strike the shore. The method of compiling the tables is explained, and the paper is illustrated by plates. H. B.

1581. *Microseismic Tremors and Barometric Variations.* **J. E. Burbank.** (Terrestrial Magnetism, 13. pp. 1–20, March, 1908. Paper read before the Philosoph. Soc., Washington, Feb. 29, 1908.)—In 1874, Rossi drew attention to the baroseismic effects, microseismic motions accompanying barometric depressions. Omori calls them pulsatory oscillations, and he observed at Tokyō two series of vibrations of periods 4 and 8 sec.; the 8-sec. period seems to be the fundamental vibration period of the plain of Tokyō. The author has made observations at Cheltenham with a horizontal pendulum seismograph of the Omori type consisting of two components, N.S. and E.W. The instruments were in 1908 mounted in a special building to avoid disturbance by the wind. Pulsatory oscillations having been noticed coinciding with a storm on Sept. 27 and 28, 1906, observations were first conducted purposely without any knowledge of the barometer. Notes on 75 cases are recorded. The tremors do not accompany depressions only, but occur often when the barometer is rapidly rising or falling; they are most pronounced when the storm centre passes from land to sea or from sea to land. G. H. Darwin has calculated that with a fall of the barometer through 1 in. the earth's surface should rise 4·5 cm. The difference of water-level will rarely be observed over the sea, where the pressure will be compensated; but the tilting of the earth's crust should be noticed at the shore-line. The strong winds may, in addition to these static pressures, set large masses of water in oscillation, and the storm waves thus created may cause vibrations in the adjacent land area. Why such vibrations should generally have a definite period—about 8.8 sec. in the Cheltenham case—is not clear, unless the period be that of the natural vibration of the locality. H. B.

1582. *Actinic Radiation of the Sun at Monte Rosa.* **C. Alessandri.** (Accad. Lincei, Atti, 17. pp. 113–118, Aug. 2, and pp. 214–225, Sept. 6, 1908.)—Observations made at the Queen Margherita Observatory with Elster and Geitel's photoelectric actinometer, show that solar actinic radiation is absorbed by the earth's atmosphere much more readily than the thermal radiation, but, unlike the latter, undergoes no selective absorption. The coefficient of transmission for actinic radiation is 0·868 compared with 0·806 for thermal radiation. W. H. St.

1583. *Large Solar Prominence.* **J. Evershed.** (Astrophys. Journ. 28. pp. 79–83, July, 1908.)—Record of a series of spectroheliograms showing the rapid growth of a very large solar prominence on Feb. 18, 1908. Visual observations had indicated a moderately bright mass of prominences, with knot-like condensations, and the twenty plates taken at intervals show the whole life-history of the prominence. Notwithstanding the sudden appearance of the mass, its subsequent increase took place gradually, and no evidence of radial velocity was shown with certainty. The max. height attained was 585″ of arc, more than one-quarter of the sun's diam. It is important to note that the disc photographs in calcium light on the same day showed no flocculi nor any kind of disturbance near the region of the prominences. C. P. B.

1584. *Rotation of the Sun.* **A. Perot.** (Comptes Rendus, 147. pp. 340–342, Aug. 10, 1908.)—A special investigation has been made to see if the powerful interferential spectroscope could be applied to the study of solar rotation. A portion of an image of the sun about 86 mm. diam. was isolated by a slit 8 m. × 0·5 m. and allowed to fall on the slit of a powerful spectroscope. The spectrum produced fell on another adjustable slit by means of which any determined radiation could be isolated, probably with the admixture of a very small amount of continuous radiation. This monochromatic beam then traversed a double system of cylindrical lenses, an interferometer plate, and there was received by the observing telescope furnished with a micrometer. Examples of the results obtained are given for two lines of calcium, one of iron and another of unknown origin. The Ca lines show very little evidence of the equatorial acceleration, while in the case of the other two lines this feature is strongly marked, and is in agreement with the determinations by other methods. C. P. B.

1585. *High Calcium Layer in Solar Atmosphere.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 147. pp. 834–839, Aug. 10, 1908.)—One of the chief difficulties encountered in the spectroheliographic registration of the upper calcium strata in the solar atmosphere is on account of the mechanical adjustment of the secondary slit to the extremely fine line constituting the double reversal. The dark flocculi which are presented when the operation is successful are of two types: (1) *filaments*, more or less elongated and straight; (2) *facular rings*, which are larger areas generally encircling faculæ. The filaments appear at all latitudes, and are more sharply defined near the limb. They often last for several days, subject meanwhile to rapid changes, and appear to have special relations to the western borders of faculæ. A very notable feature is that they give indications of considerable radial velocity, contrary to the general type of matter which is photographed with K_3 radiation. Velocities up to 40 km. per sec. have thus been recorded. Using this K_3 radiation it is also found that the prominences round the limb are photographed with the same duration of exposure as the disc. [See also Abstract No. 598 (1907).] C. P. B.

1586. *Solar Vortices.* **G. E. Hale.** (Astrophys. Journ. 28. pp. 100–116, Sept., 1908.)—Remarkable photographs of the solar surface have recently been obtained by the author at Mount Wilson by means of the $H\alpha$ line of hydrogen taken through the large spectroheliograph. These show detail of quite a different nature to that shown on the calcium plates, and on several days special storm areas have been distinctly recorded. Evidences of cyclonic movement are very clearly presented, and the photographs reproduced show the absorption of a dark hydrogen flocculus into the disturbed area of a spot on July 8, 1908. The mean of six measures gave the velocity of approach of the flocculus as 106 km. per sec. Dealing with the magnetic effect associated with large sun-spots, the author suggests that a segregation of positively or negatively charged particles rotating in the solar vortex would give rise to magnetic lines of force at right angles to the plane of the vortex. If this be the case it would affect the light radiated from the spot along these lines of force, producing a doubling of the spectrum lines with the two components circularly and oppositely polarised. To test this special spectrograms were obtained in which the solar light was passed through a Fresnel rhomb and nicol prism before falling on the slit-plate. The spectrum was then photographed with the nicol in positions varying by 45°. Photographs are reproduced clearly showing the doubling of the iron line at λ6302·71, thus completely confirming the presence of a magnetic field. C. P. B.

1587. *Solar Magnetic Fields.* **P. Zeeman.** (Nature, 78. pp. 369–370, Aug. 20, 1908.)—Commenting on the paper of Hale dealing with the detection of a magnetic field in sun-spot areas [see preceding Abstract] Zeeman endorses the opinion of Hale that the evidence is decisive. So far as is known at present, only a strong magnetic field can resolve a single line into a doublet having components circularly polarised in opposite directions. In order to obtain an idea of the order of magnitude of the magnetic force within the Hale solar vortex, the separation measured, 0·22 Å.U., is compared with separations determined with the iron arc in the laboratory. The field is shown to be about 6,000 gauss. If we regard the Hale vortex as a solenoid with axis parallel to that of the vortex, and having one layer of one winding per cm., a current of 5,000 amps. would be necessary to generate such a magnetic field. This seems very large, but a closer idea of the actual case is given by substituting for the single winding per cm. a gaseous conducting circular disc, 1 cm. thick, and of suitable radius, say equal to that of the earth, $6{\cdot}4 \times 10^8$ cm.—this will give a current of $0{\cdot}8 \times 10^{-5}$ amp. per sq. cm. As the kathode rays in a Wehnelt tube carry a current of about 10^{-5} amp., it appears that on the above estimate the solar vortex would not be overcrowded with electrons. C. P. B.

1588. *Relative Depth of Sun-spots.* **W. Krebs.** (Astronom. Nachr. No. 4267. p. 315, Aug. 7, 1908. Nature, 78. p. 402, Aug. 27, 1908. Abstract.) —From measures made with a stereocomparator on solar photographs taken at Greenwich on July 4, 5, and 6, the author shows that different spots in the group near the central meridian were of different depths, and the differences of level changed during the intervals separating the photographs. C. P. B.

1589. *Apparent Dispersion of Light in Interstellar Space and Lebedew's Hypothesis.* **J. Stein.** (Comptes Rendus, 147. pp. 228–230, July 27, 1908.) —Lebedew, rejecting the hypothesis of actual dispersion in space [Abstract No. 1242 (1908)], seeks the explanation of the interesting phenomena discovered by Nordmann and Tikhoff in the physical properties of certain variable stars. This explanation, however, itself presents rather serious difficulties. To begin with, it only applies to variables of the Algol type, whereas Tikhoff, by the method of radial velocities, has found an analogous difference of phase between the red and blue orbits of a star, β Aurigæ, which is not variable at all. It is true that this result is uncertain, but if later researches confirm it, another hypothesis will have to be sought to explain it. There is, however, a difficulty of another kind. Though Lebedew's hypothesis is slightly vague, there appears little doubt that it depends on selective absorption of light in the atmosphere of the satellite. But Pannekoek, in his thesis on Algol [Leiden, 1902, pp. 21–22], has advanced a very plausible argument to show that, in calculating the brightness of Algol during the eclipse, the gradual increase of absorption in the satellite's atmosphere may be neglected, and the satellite considered as a dark disc with sharply defined edge. It is sufficient for the purpose to assume that the absorption undergone by a ray of light in traversing the atmosphere of the satellite is proportional to the density at the point where the ray passes nearest to its centre. If ρ_1, ρ_2, are the densities at two altitudes h_1, h_2, expressed in km., and if gravity on the satellite is k times as great as on the earth, the ordinary rough law for decrease of atmospheric density with height gives $\rho_1/\rho_2 = e^{-\frac{k}{8}(h_1-h_2)}$. If $k=1$, then $\rho_1/\rho_2 = 0{\cdot}001$ for $h_1 - h_2 = 55$ km. Then, if 99·5 per cent. of a certain ray is transmitted, only 1 per cent. cent., will be transmitted for a ray passing 55 km. nearer the centre. Since k is probably greater than unity, it follows that in the satellite's atmosphere the transition from nearly total absorption to nearly total transparency will be effected with such narrow limits that practically the eclipsing star may be considered as a disc. Though the dimensions of the disc will differ slightly for different spectral regions, the differences will be negligible in comparison with the diam. Lebedew refers to a memoir of Schwarzschild's as authority for his statement that the difference in the weakening of light in different spectral regions shows that the satellite is surrounded by an extensive gaseous envelope which absorbs the light of the central star. The author points out that in the memoir cited Schwarzschild does not attribute the difference in luminous variation of η Aquilæ, in different spectral regions, to selective absorption by the atmosphere of a satellite, but to selective absorption by the star's own atmosphere. He even expressly states that the luminous variations of this star cannot reasonably be explained by an eclipse. A. E.

1590. *New Variable Star of very Short Period discovered at Paris Observatory.* **J. Baillaud.** (Comptes Rendus, 147. pp. 230–232, July 27, 1908.)—In the course of an investigation into the distribution of stars in certain regions of the chart of the heavens the author has found, on a plate taken by the brothers Henry in 1900, a new variable star having, like those discovered last year, a variation so rapid "that the passage from minimum to maximum appears to be completely effected in half an hour during the duration of one of the three exposures of the plate." The star's mean co-ordinates for 1900·0 are R.A. = 14h. 41m. 31·30s., Dec. = 28° 43′ 59·7″ N. The star is missing on the heliogravure enlargement, although much fainter stars are visible. The deformation, due to its varying brightness, has probably caused it to be taken for a false image and removed in the retouching process. Between June 24 and July 10 thirty photographs were taken, which have enabled the variability of the star to be verified. The brightnesses at maximum and minimum respectively are 12·8 and 14·3 magnitudes. The passage from minimum to maximum requires about 1h. 41m. That from maximum to minimum is still of uncertain duration, the observations being equally well represented by a period of 11h. 51m. 48s. = 0·4942 day, or one of 7h. 54m. 26s. = 0·3295 day, two-thirds the former. A series of photographs, taken on June 29, indicate a maximum at 11h. 34m. 28s. Paris mean time. The star is of the δ Cephei type. The period of increasing brightness, 1h. 41m., is much shorter than that of decreasing, which may be either 6h. 13m. or 10h. 10m. There appears to be a halt on the downward grade, perhaps a secondary maximum, 1h. 40m. after the principal maximum. A. E.

1591. *Spectrum of Nebula HV 15 Cygni.* **M. Wolf.** (Astronom. Nachr., No. 4271, p. 379, Aug. 29, 1908. Nature, 78. p. 471, Sept. 10, 1908. Abstract.)—Spectrum photographed with the Waltz reflector on Aug. 3, with an exposure of 3¼ hours. Gaseous spectrum, showing lines at 373, 434, and 500, with indications of others at 369, 397, and 411. C. P. B.

REFERENCES.

1592. *Measurement of Angular Velocity.* **J. Tuma.** (Phys. Zeitschr. 9. pp. 565–569, Sept. 1, 1908. Phys. Inst. d. k.k. deutsch. techn. Hochschule, Prag, July 6, 1908.)—Describes a method of determining the momentary value of an angular velocity by use of a Hipps chronoscope. Numerous photographs of the apparatus and diagrams illustrative of the method of use are given in the paper. A brief description of the apparatus cannot be given, but the method of use is fairly simple. A. W.

1593. *Errors of Micrometer Screws.* **E. Keil.** (Zeitschr. Instrumentenk. 28. pp. 243–245, Aug., 1908.)—Determination of micrometer screw errors by mounting them in conjunction with a standard Michelson interferometer. C. P. B.

1594. *Structure of the Atom.* **O. Lodge.** (Soc. Chem. Ind., Journ. 27. pp. 731–739, July 31, 1908. Hurter Memorial Lecture, read before the Liverpool Section.)—Deals with the subject under the following sub-headings: Chemical affinity; Residual affinity and cohesion; Electrical view of matter; Theory of electrons; Electric mass; Electron history; Spectra; Atomic structure; with an Appendix on absolute temperature.

1595. *Stationary Vibrations in the Surface between two Fluids.* **W. Schmidt.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 91–102, Jan., 1908.)—A mathematical discussion of stationary waves between two fluids. Formulæ for the oscillation period in several cases are deduced and the theoretical values tested by means of the results of various experimenters. An interesting case is that of two layers of water at different temperatures, which is treated at some length, reference being made to the researches of Watson on the movements of the waters of Loch Ness [Abstract No. 726 (1904)]. A. W.

1596. *Representation of Earth's Surface by Spherical Harmonics of the First Three Degrees.* **A. E. H. Love.** (Roy. Soc., Proc. Ser. A. 80. pp. 553–556, June 20, 1908.)—This is a sequel to the author's paper on the gravitational stability of the earth [Abstract No. 1293 (1907)]. According to that paper a surface of equal density should be represented by an equation of the form $r = a + a_1S_1 + a_2S_2 + a_3S_3$, where a, and a_1, a_2, a_3 are constants, and the a's small, and S_1, S_2, S_3 are spherical surface harmonics of the first three degrees respectively. In the former paper he made certain estimates of the values of the variables as functions of the latitude and longitude which should make the earth's surface correspond approximately with the actual distributions of land and water. In the present note he revises his estimates, and the revised distribution shows limits of the continents and oceans in close agreement with the reality. S. H. B.

1597. *On Ice and its Natural History.* **J. Y. Buchanan.** (Nature, 78. pp. 379–382, Aug. 20, 1908. Abstract of paper read before the Royal Institution, May 8, 1908.)

1598. *Graphical Determination of Solar Energy.* **E. Doležal.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 255–278, Feb., 1908.)—Analytical determination of the formula for the amount of solar energy received by the earth with the sun at varying declinations during the year, the results being plotted graphically. C. P. B.

1599. *Transit of Mercury, November* 14, 1907. **C. Sanders.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 108–110, Sept. 8, 1908.)—Observations of the transit at Chiloango, Portuguese West Africa, with a Zeiss telescope of 80 mm. aperture and 120 cm. focal length, using a power of 133. Beginning of transit obscured by clouds; times of third and fourth contact given in comparison with computed values. C. P. B.

1600. *Mathematical Theory of Star Drifts.* **A. S. Eddington.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 588–605, June, 1908.)—The analysis is given of an attempt to obtain from the observational data of proper motions of stars the direct equations necessary to determine the constants of the drifts into which it is supposed the star system may be divided. In the second part of the paper the theory is applied to the analysis of the proper motions of the zodiacal stars from the papers of the American ephemeris. C. P. B.

1601. *Stars having Peculiar Spectra. Fifteen New Variable Stars.* **E. C. Pickering.** (Astrophys. Journ. 27. pp. 80–84, Jan., 1908. Harvard Coll. Observatory Circular, No. 132.)

LIGHT.

1602. *The Transparency of Boric Anhydride.* **T. Lyman.** (Astrophys. Journ. 28, p. 85, July, 1908.)—Fritsch and Zschimmer both have remarked upon the transparency of B_2O_3 to ultra-violet light [Abstracts Nos. 1629, 1806 (1907)], and the author has definitely determined this for the region more refrangible than λ = 1850. He finds that the transparency is less than that of quartz and of the same order as that of purple fluorite. A layer of 1–2 mm. is not transparent to light of shorter wave-length than λ = 1700. [See Abstracts Nos. 1052 (1906) and 404 (1907).] E. C. C. B.

1603. *Pressure of Light on Gases.* **P. N. Lebedew [Lebedev].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. 1. pp. 20–21, 1908.)—If a quantity E of light-energy falls on a gas per sec., and the fraction a of this quantity is absorbed by the gas, the pressure exerted by the light on the gas will be $p = aE/V$, where V is the velocity of the light. The author describes experiments made to determine this pressure by investigation of the movement produced in a gas by a bundle of light-rays. The experimental pressures agree well with the values calculated by means of the above equation, considering that an error of 1×10^{-6} dyne per sq. cm., in some cases, makes a difference of 80 per cent. The detailed results are to be published later. T. H. P.

1604. *Reflection at Surface of Water.* **W. Schmidt.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 75–89, Jan., 1908. From the k.k. Zentralanstalt f. Meterologie u. Geodynamik.)—A calculation of the amount of unpolarised light reflected from the surface of water is made for various angles of incidence from 0° to 90°. If R is the amount reflected and I the amount of the incident light, then Fresnel's theory gives—

$$R/I = \tfrac{1}{2}\sin^2(i - r/\sin^2(i + r) + \tfrac{1}{2}\tan^2(i - r/\tan^2(i + r),$$

where i is the angle of incidence and r the angle of refraction. For 0°, R/I = 2·04 per cent., and the ratio gradually increases to 5·97 per cent. for 60°. Beyond this the ratio increases very rapidly to 100 per cent. at 90°. The values obtained in this way were tested experimentally for the sun's rays by means of an Ångström pyrheliometer. The results obtained were remarkably close to the theoretical values, showing that Fresnel's formula is true in this case. The author next discusses the effect of the light and heat reflected from the surface of the sea on the climate of different parts of the earth. He shows that this reflected light and heat must have a considerable effect on the climate of places near the sea-shore and on the banks of large lakes—especially the eastern and western shores—and will considerably influence the growth of vegetation. The same conclusion was arrived at by Dufour in researches on the reflection of solar heat. A. W.

1605. *Phase-change at Normal Metallic Reflection.* **J. Koenigsberger and R. Bender.** (Ann. d. Physik, 26. 4. pp. 763–788, July 28, 1908.)—An account of experiments on the phase-change of light by reflection at normal incidence from various metals and metallic compounds of which the chief results are as follows : (1) Light from a mercury arc lamp being used and the reflections from glass to Pt and Au being measured, it was found that the reflections for films of more than 50 $\mu\mu$ are the same as for massive Pt. The coherent Au and Ag films from Roessler's solution have consequently the optical properties of massive Pt. (2) Under about 50 $\mu\mu$ thickness of films the retardation for Au and Pt is less than for stronger films. (3) The different colours of thin gold films is to be traced in part to the effect of chemical compounds. (4) For substances which are transparent in the extreme red, the phase-change may be conveniently determined from the interference bands in the spectrum of the reflected light. This method was used for iron glance, manganite and antimony glance. (5) For pyrites the authors adopted the method devised by H. Kath for quite opaque substances. (6) The phase-change by reflections from glass to Pt and Au increases with increasing thickness of film of these metals in the sense of a retardation from 0 to 0·6λ compared with that to air. (7) The yellow colour of the thinnest surface skins (under 20 $\mu\mu$ thick) of many metals depends upon the dispersion of the phase-change of these metals. E. H. B.

1606. *Magnetic and Electric Birefraction of Nitrobenzene. Variation with Wave-length.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 147. pp. 193-195, July 20, 1908.)—Measurements of the angle β, which fixes the value of the magnetic birefraction, for nitrobenzene for various wave-lengths, shows that its value increases regularly as the wave-length diminishes and rather more rapidly than the reciprocal of the wave-length. The electric birefraction of nitrobenzene for yellow mercury light at 22° is 97 times as great as that of carbon disulphide. Within the limit of experimental accuracy, the dispersion of the electric birefraction of nitrobenzene is equal to the dispersion of the magnetic birefraction. The two phenomena hence appear to have a common origin. [See Abstracts Nos. 2046 (1905), 585 (1906), 1508 (1907), 288 (1908).] T. H. P.

1607. *Aberration of Sloped Lenses and their Adaptation to Telescopes.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 81. pp. 26-40, July 30, 1908.)—The paper is divided into two parts, and the second part treats of the advantage attending a magnification which is unequal in different directions and of the methods available for attaining it, including the sloped object lens. In the first part it is shown by analytical methods how the unsymmetrical aberration thus introduced may be minimised so as to become unimportant. Among the results found in the first part is the condition for no aberration, the inference that for a plano-convex lens of index 1·618, neither kind of aberration is important at moderate slopes, and a table of obliquities of the incident ray for which the plano-convex lens of variable index is free from aberration in the primary and secondary planes respectively. The behaviour of a telescope is described in which the eyepiece consisted of a 6-in. spherical lens and a 2½-in. cylindrical lens combined with a 14-in. objective. Care must be taken that the axis about which the object lens is turned is truly perpendicular to the axis of the cylindrical component of the eyepiece. G. E. A.

1608. *Optical Constants of Gypsum at Different Temperatures.* **A. E. H. Tutton.** (Roy. Soc., Proc. Ser. A. 81. pp. 40-57, July 30, 1908.)—Mitscherlich showed in 1826 that gypsum (selenite), the crystallised hydrated sulphate of lime, suffers greater change in the position of its optic axes under the influence of heat than any other substance then examined. At ordinary temperature it is bi-axial, with an optic-axial angle of about 60°, but when heated to 100° C. the axes come together, producing in convergent polarised light the rectangular cross and circular rings of a uniaxial crystal. This may be demonstrated in a projection lantern polariscope by means of the heat from the lantern alone. The phenomenon of crossed axial-plane dispersion is due to very low double refraction, combined with very close approximation of the intermediate index of refraction to one of the extreme indices, and to the fact that change of wave-length of the light or change of temperature, or both, cause the intermediate index to approach still nearer to the extreme one in question until it becomes identical with it, and eventually to pass it. The cross and rings are produced at the critical point of identity which is a function of both wave-length and temperature. The temperature and optical-axial angle have a maximum for wave-length 578. In determining the temperature effect it was necessary, owing to optical differences in crystals from the same crop, to make all the tests on specimens cut from one crystal, and tables are given of the three refractive indices for the temperatures 12·5° and 105° C. For four crystals examined the temperature of production of cross and rings averaged 110° C. G. E. A.

1609. *Visual Illusion and Fixation.* **J. Fraser.** (Nature, 78. p. 188, June 11, 1908. From "Journ. of Psychology.")—A new visual illusion is described. It consists of letters or figures on a chequered background of black, grey, and white squares. The outlines of the letters are traced, not in continuous lines, but are represented by a band consisting of short lines alternately black and white, slightly inclined to the direction of the limbs of the letter so as to appear like a twisted cord composed of black and white strands. The letters then appear to be inclined several degrees from their actual direction.

H. W. P. Y.

1610. *Direct Photometry of Luminous Sources.* **C. Féry.** (Journ. de Physique, 7. pp. 632–640, Aug., 1908. Paper read before the Soc. franç. de Physique, May 1, 1908.)—Numerous attempts have been made to obtain photometric measurements without using the eye. Unhappily, however, a substance having the same sensibility as the retina to light has not yet been found. The results obtained by photometers which depend on the chemical action of light, on the variation of the resistance of selenium, &c., must be erroneous when the sources are heterochromatic. The author proposes—instead of measuring the total energy from the source—to measure only the sum of the rays of the various wave-lengths which produce impressions on the retina, the intensity of each of the elementary rays being made proportional to the action it produces on the retina. The absorption of rays in the infra-red and the ultra-violet portions of the spectrum must be complete, and for Langley's wave-length 0·54 μ it is zero. For other wave-lengths the factors of illumination indicated by Lépinay and Nicati (Ibid. 2. (ser. II.), p. 64, 1883) are employed. In order to remove the radiations producing no effect on the retina, a screen limiting the height of the spectrum at the various points can be employed. This screen has the form of the curve of retinal sensibility and all the radiations are concentrated on the measuring apparatus. A simpler method is to use a suitable absorbing liquid. Green solutions proved unsatisfactory, as they did not absorb the infra-red rays sufficiently, but solutions of the copper salts, more particularly acetate of copper, proved perfectly satisfactory. Varying the concentration of a solution of acetate of copper, the transmitted ray of max. energy can be made to coincide with 0·54 μ. In this case experiment shows that only between 0·1 to 0·4 per cent. of the total radiation from a Bengel or an Auer lamp is transmitted. To measure this radiation the radio-micrometer of C. V. Boys was found to be admirably adapted. Using a Bengel lamp it was found that when the light traversed, 2, 3, 7 and 14 cm. of water respectively the deflections produced were 468, 98, 46, and 30 mm. respectively. It will be seen that the absorption increases very slowly when the thickness is greater than 3 cm. The results of experiments on solutions of various salts are given. The great absorption of the solutions makes the use of a lens compulsory. Considerable practical difficulties arose from the drifting of the zero, but the method of reading devised eliminated errors due to this cause. Comparing an Auer lamp with a Bengel lamp with his apparatus the author obtained 4·98 as the ratio of their luminous intensities. With a Lummer and Brodhun photometer he got 4·88. He also tested an ordinary carbon filament, a tantalum filament and a "Z" lamp with the following results:—

Carbon filament	0·295	candle per watt.
Tantalum filament	0·746	„ „
"Z" filament	1	„ „

These agree with the ordinary photometric measurements. The ratio of the luminous to the total radiation from an ordinary 110-volt lamp he finds to be only 0·314 per cent. At 97 volts the efficiency of this lamp was 0·187 per cent. The Auer lamp has an efficiency of 0·401 per cent. but the Bengel lamp gives only 0·0914 per cent. The author is testing in a similar way arc lamps and mercury vapour lamps. A. R.

1611. *Lippmann Colour Photography.* **H. E. Ives.** (Astrophys. Journ. 27. pp. 325–352, June, 1908.)—A smaller amount of silver bromide than is usually employed gives purer reflected light from the Lippmann film. Increase in thickness of the film causes no corresponding increase of purity so long as pyrogallic acid development is used. The standing waves are formed throughout the thickness of the film; non-formation of laminæ is due to surface-action of the developer. Other developers (hydroquinone) develop evenly through the film; and, by bleaching the deposit formed by their use, films are obtained giving purer reflected colours than hitherto obtained, and increasing in resolving power with thickness. Films developed with pyrogallic acid have small capacity for rendering complex wave-structure (mixed colours), but luminosity values are well preserved if the grain is not too fine or exposure too long. With hydroquinone and bleaching, complex radiations are reproduced with a fidelity dependent only on the practically attainable thickness of film; this resolving power is at the cost of luminosity. White is produced by the action of white light on fairly coarse-grained, rigidly isochromatic emulsions. The colours of natural objects are well reproduced by emulsions suitable for giving white and mixed colours, *i.e.*, of somewhat coarser grain than is best for pure colours: pictures of natural objects are more difficult to obtain than those of pure colours because of shallowness of the resultant standing-wave structure. A means has been found of affixing a flexible silver reflecting surface in optical contact with the film, enabling the mercury mirror to be dispensed with. The Lippmann film, by reason of its capacity for reproducing pure colours, is well adapted to application to three-colour photography. A. D.

1612. *Interference Fringes in Lippmann Colour Photography.* **E. Rothé.** (Comptes Rendus, 147. pp. 43–45, July 6, and pp. 190–192, July 20, 1908.)—Fringes in photographs of the spectrum are described, visible from the glass side, due to the deposition of silver by the stationary waves, modified in their form by irregularities in the thickness of the gelatine, closer together the thicker the gelatine is, and indicating the intersections of the plane of the glass with the stationary waves which vary at different parts of the spectrum under the differing wave-lengths. The glass takes no part in their formation; they are not the ordinary fringes of thin films; each spectrum has its own proper fringes; the number of the fringes in the spectrum depends on the thickness of the gelatine, but apparently does not depend on the dispersion. Brilliant results are obtained by backing the sensitive film with a thick layer of colourless gelatine; this stops parasitic interference-phenomena and accessory reflections. A. D.

1613. *Sensitiveness of Photographic Plates at different Temperatures.* **R. J. Wallace.** (Astrophys. Journ. 28. pp. 39–51, July, 1908.)—With "Seed 27 Gilt Edge" plates, between 24° and 75° the curves for the respective temperatures cross one another, so that for fainter stars the plate becomes slower as the temperature is increased, while for brighter stars the converse is the case. At about the minimum of photographic action the sensitive plate is faster by about 0·85 star magnitude in a temperature range of from —18° to 32° C., and for the brighter stars about 0·7 magnitude slower, while for stars of medium magnitude (about 8) there is no apparent change. Photographic sensitiveness plotted against temperature may be represented by a curve similar to the probability curve. A. D.

1614. *Destruction of an Image by Visible Rays of Low Refrangibility.* **W. de W. Abney.** (Photographic Journ. 48. pp. 318–319, Aug., 1908.)—A sensitive plate which has been exposed to white light just so long as to cause a faintly marked fog if the plate were developed, and then exposed to the rays of a spectrum has, when developed, an impression of the colours at the blue end of the spectrum; but, on that part of the plate where the orange and red rays fell, the fog is less intense than in the surrounding parts. By placing a red or orange glass in front of the slit of the spectroscope, and giving a more prolonged exposure, the clearance of the fog may be made complete. Bromo-iodide of silver and other sensitive salts are equally liable to this reversing action by the rays of low refrangibility. G. E. A.

1615. *Pseudo Photographic Phenomena.* **P. Villard.** (Journ. de Physique, 7. pp. 506–520, July, 1908. Paper read before the Soc. franç. de Physique, Jan., 1908.)—Consider a negative, whether not yet fixed or fully fixed and dried; expose it to the action of a silvering bath, that is, to the simultaneous action of a reducing agent and a solvent of silver (sulphite or hyposulphite of soda), which is the case where a negative is transferred directly from the developer to the fixing bath; then the gelatine is silvered by accretion of silver particles to nuclei in the gelatine other than the existing particles of reduced silver, which particles are avoided by the new deposit. The clear glass thus becomes most stained ("dichroic fog"). If the process goes on, the new deposit forms a positive picture which may even come to overpower the original negative, transforming the whole into a positive, of which the densest portions of the original negative are now the least opaque portions. Similar deposits of silver, gold, palladium, platinum can be formed in ordinary gelatine. Manganic hydrate acts like metallic silver in repelling the new deposit; and so do many other precipitates, but not all; in many cases there is an attraction. A negative cleared by Farmer's solution and fixed, will apparently present no trace of an image: but if it be immersed in a silvering solution, first the original negative will be restored, and then dichroic fog will begin, and the new deposit go on to the production of a dense positive. *Silhouettage.*—In all the preceding cases there is a clear line separating the former deposit from the new deposit; the repulsion between them extends for a certain distance from the particles of the former deposit. This repulsion exists between any two deposits which differ in their physical condition, *e.g.*, between the silver deposit due to exposure of part of a plate and immersion of the whole in the developer, and that produced on then exposing the remainder of the plate wet and re-immersing in the developer; the two regions are separated by a clear line which is in no way due to the action of light. A. D.

1616. *Photographic Effect of Metals and of Hydrogen Peroxide.* **S. Saeland.** (Ann. d. Physik, 26. 5. pp. 899–917, Aug. 25, 1908. Physikal. Inst. d. Univ., Heidelberg, May, 1908.)—The effect upon a photographic plate of certain metals (Mg, Zn, &c.) placed in contact with it has been variously attributed to chemical action, a radiation, and to an emanation [see Abstracts Nos. 885, 1002, and 1376 (1908)]. The author's experiments decide in favour of the first of these. On cleaning the surface of the metal with emery and then placing it in contact with or very near to a photographic plate for a considerable time, a photographic effect is observed. The effect is greatest with Mg, next with Al, and then Zn, but the more active the metal at first the more rapidly does its activity diminish. Fresh cleaning of the surface in all cases brings the metal to its max. activity. Several amalgams, particularly that of Zn, behave in the same way. If some time elapses between exposure of the plate and its development, the intensity of the stain is much greater; also a rise of temperature increases the effect. The effect diminishes with fall of air pressure, and vanishes in a vacuum or in dry hydrogen; it also vanishes if the air is perfectly dry—in fact, the conditions for the production of H_2O_2 seem to be necessary for the effect to take place. A solution of this substance has a similar action to the metals. Very thin sheet Al stops the effect, as also does a transverse stream of air of 5 m. per sec. The author concludes that the effect is due to the presence of H_2O_2 and its ordinary chemical effect upon the plate. S. G. S.

1617. *Polarisation of Light by Reflection from Glass.* **L. Zehnder.** (Ann. d. Physik, 26. 5. pp. 998–1018, Aug. 25, 1908.)—The condition of the light reflected from glass surfaces is investigated by means of the instrument described in a previous paper [Abstract No. 1688 (1908)], the conclusions arrived at being as follows: (1) Ordinary unpolarised light when reflected from glass is transformed, not into plane, but into elliptically polarised light. (2) The component polarised perpendicular to the plane of incidence never disappears in reflected light, but has a minimum value for the principal angle of incidence. (3) If the polarising angle is defined as the angle for which the above component is least reflected, the principal angle of incidence and the polarising angle coincide. But it follows from this that (4) the polarising angle cannot be calculated with certainty from Brewster's law by means of the refractive index for glass as determined by the method of minimum deviation or any other method. G. E. A.

1618. *Series in Alkali Metal Spectra.* **F. A. Saunders.** (Astrophys. Journ. 28. pp. 71–78, July, 1908.)—Bergmann has recently announced [Abstract No. 915 (1908)], among other new series, one in the spectrum of cæsium, which Runge thinks is related to the first subordinate series of that element [Abstract No. 605 (1908)]. Ritz has very lately noted the fact that this series is not entirely new, and that there are very serious objections to Runge's proposition [see Abstract No. 1106 (1908)]. The author here tabulates the complete series, so far as now known, and shows that the series formula is $1/\lambda = \left\{ \begin{matrix} 16899{\cdot}6 \\ 16802{\cdot}0 \end{matrix} \right\} - 109675/(m + 0{\cdot}9762)^2$. Runge believes that this series may be a second sort of principal series, closely related to the first subordinate series. Ritz objects to this on the ground that the wave-number differences are constant. The stronger line of each pair has the greater wave-length; this is characteristic of all subordinate series and is just opposite to the principal series arrangement. The third subordinate series, found by Lenard in the sodium spectrum, seems to be very similar to this one in the cæsium spectrum. It presents a similar hazy aspect, is equally faint, and has a wave-number difference which does not agree with that of the usual series; but it seems to run to the same end as these, wherein it differs from the new cæsium series. Bergmann finds a new line at λ12680 in the sodium spectrum. This is probably an unresolved pair belonging to Lenard's series. Considering this to be the case, it can be included with the others in a formula similar to that of Ritz. The formula contains four adjustable constants, and is not to be recommended for its simplicity. A. W.

1619. *Spectrum Series Law.* **W. Ritz.** (Phys. Zeitschr. 9. pp. 521–529, Aug. 15, 1908.)—Gives a new formula for determining the wave-length of lines in spectral series. The formula is—

$$\nu = \mathrm{A} - \mathrm{N}/[m + \alpha + \beta\mathrm{N}/m^2 - 2\alpha\beta\mathrm{N}/m^3 + \ldots]^2,$$

where ν is the reciprocal of the wave-length *in vacuo*, N the universal constant 109675, and m the number of the line considered. The constants α and β depend upon the kind of series. The author discusses the formula, and shows, from the measurements of Lenard, Konen and Hagenbach, Saunders, and others, that it gives results in very good agreement with the observed values of the series lines in the spectra of the alkali metals and alkaline earths. A. W.

1620. *Relative Intensities of Spectrum Lines.* **P. G. Nutting.** (Astrophys. Journ. 28. pp. 66–70, July, 1908.)—An attempt is made to consider the intensity of a spectrum line as expressible in terms of only two constants and one independent variable. The two constants are the intersection and slope of the curve relating line-energy to total energy, while the variable is the specific energy-content of the luminous gas, or as this quantity is difficult of determination, the potential gradient is employed instead. C. P. B.

1621. *Wave-length of Remainder Rays from Gypsum.* **J. Koch.** (Ann. d. Physik, 26. 5. pp. 974–984, Aug. 25, 1908. Physikal. Inst. d. Univ., Upsala, June, 1908.)—A redetermination of the wave-length of a band in the infra-red, by means of rays reflected from several plates of gypsum, Aschkinass having found a maximum at $8{\cdot}69\,\mu$ [Abstract No. 626 (1900)]. Bolometric examination of the rays after reflection from three and from five gypsum surfaces gives the reflection maximum at 8·68 μ and the half-breadth of the band as 0·24 to 0·25 μ. The band is fairly broad, but simple and symmetrical.

G. E. A.

1622. *Zeeman-effect in Weak Magnetic Fields* **O. v. Baeyer and E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 10. 10. pp. 357–365, May 30, and 10. 12. pp. 423–428, June 30, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—An investigation of the magnetic resolution of the two yellow Hg lines: in both cases no asymmetry of the outer components was visible. The middle component, however, is broad and somewhat ill-defined, and the authors trace the previous observations of asymmetry to the difficulty of measurement of the centre of this line.

E. C. C. B.

1623. *The Zeeman Phenomenon and the Second Law of Thermodynamics.* **O. M. Corbino.** (N. Cimento, 16. pp. 124–129, July–Aug., 1908.)—The author discusses first the case of a single spherical source of radiation surrounded by a concentric spherical mirror reflecting on its internal surface, and placed in a uniform magnetic field AB. The principle is assumed that the source absorbs the same radiations which it emits, the incident rays having the same polarisation and the same wave-length λ as those emitted. The source emits in the simple case supposed: (1) a vibration of wave-length λ parallel to the magnetic field; (2) a circular vibration λ_1 in the direction of the magnetising current; (3) a circular vibration λ_2 in the opposite direction to the current, and $\lambda_1 < \lambda < \lambda_2$. The optical effect for any direction is the sum of the projections of the three vibrations on the plane at right angles to the ray. He then considers the case of two sources identical in energy, S_1 and S_2, of which S_1 is placed in a magnetic field at right angles to the line S_1S_2, S_2 in a magnetic field in direction S_2S_1, each surrounded by its own spherical internally reflecting mirror concentric with itself; but each reflector has an aperture centred on S_1S_2, and the radiation through the apertures are collected by a lens in suitable position, so that those from S_1 are collected in S_2, and *vice versâ*. This being the case, he shows that, if the energy emitted by each source is unity, that absorbed by S_1 is 2/3 of its own and 2/3 of that from S_2, that is 4/3, and by S_2, 2/3. If, therefore, the radiations are heat radiations, the second law of thermodynamics is violated. He discusses several hypotheses on which the apparent violation may be compensated, and the second law re-established, only to reject them. His conclusion is as follows: That two sources of light identical in spectrum lines, sensitive to the magnetic field, and suitably arranged, absorb unequally the radiations which each receives from the other. Therefore a metallic vapour at high temperature, not accompanied by any chemical or electrical processes, either does not emit line-spectra, or if it does, should not give rise to the Zeeman phenomenon, referring here to Zeeman's latest experiments [Abstract No. 788 (1908)]. Also that it is only for band spectra that the emission is proved to be of heat, and, therefore, that band spectra are not affected by the magnetic field.

S. H. B.

1624. *Fluorescence of Platinocyanides.* **L. A. Levy.** (Chem. Soc., Journ. 93. pp. 1446–1463, July, 1908.)—The mode of preparation of certain platinocyanides exerts a great influence on the intensity of the fluorescence exhibited. By suitable methods some of these can be obtained in two modifications having the same crystalline form, the two varieties showing a remarkable difference in their optical properties, differing in colour and very greatly in the intensity of their fluorescence. The barium and calcium salts exhibit considerable, and the cerium salt only slight fluorescence. Most, but not all, platinocyanides fluoresce under the stimulus of radium radiations. It is remarkable that uranyl platinocyanide fails to respond to the stimulus of ultra-violet light or radium radiations, both the uranyl and platinocyanide groups usually conferring the property of fluorescence on salts containing them. Attempts to determine if a crystal of platinocyanide becomes electrically charged when fluorescing under the action of ultra-violet light gave negative results. T. H. P.

1625. *Secondary Kathode Rays produced by Röntgen Rays.* **J. Laub.** (Ann. d. Physik, 26. 4. pp. 712–726, July 28, 1908.)—The author's experiments on platinum, soot, and aluminium lead to the following conclusions: When Röntgen rays impinge on a body, there are formed, in addition to the secondary Röntgen rays, kathode rays, the quantity of which increases with the density of the body employed. The intensity of the secondary kathode rays depends also on the intensity and hardness, and, further, on the angle of incidence of the primary Röntgen rays, just as with kathode and canal rays. The velocity of the secondary kathode rays increases with the hardness of the primary Röntgen rays, but is independent of their intensity. T. H. P.

1626. *Retardation of α-Rays by Metal Foils.* **T. S. Taylor.** (Amer. Journ. Sci. 26. pp. 169–179, Sept., 1908. Contribution from the Sloane Lab. of Yale College.)—Observations were made by an improved method on the variations of the air equivalent by which is meant the diminution of the range of the α-particle produced by a sheet of metal foil when placed over the source of rays, or the amount by which the range of the α-particles in air is cut down by their passage through the foil. The apparatus employed was similar to that used by Bragg, and polonium was taken as the source of the rays. It was found that the air equivalents of metal foils decreased with the range (*i.e.*, with the speed) of the α-particles entering them. The change is very small for thin foils of the lighter metals when the range of the α-particles is high; but when the range is low for thin sheets, or when the sheets are thicker, the change becomes quite marked. On comparing the change for sheets of different metals of nearly equal air equivalents the rate of change was found to be in the order of the atomic weights of the metals. J. J. S.

1627. *α-Particles from Radio-active Substances.* **E. Rutherford** and **H. Geiger.** (Roy. Soc., Proc. Ser. A. 81. pp. 141–161, Aug. 27, 1908.)—The total number of α-particles expelled per sec. from 1 gm. of radium has been estimated by Rutherford by measuring the charge carried by the α-particles expelled from a known quantity of radium in the form of a thin film [see Abstract No. 1881 (1905)]. This number was reduced to one-half when it was found that the α-particle should have a charge 2*e* [Abstract No. 1871 (1906)]. The present paper describes an electrical method of counting the α-particles directly, without any assumption of the charge carried by each. The method employed is based on the work of Townsend, who has worked out the conditions under which ions can be produced by collisions with the neutral gas molecules in a strong electric field [see Abstracts Nos. 1108 (1901), 2244 (1902), 1426 (1903), and 144 (1904)]. In Rutherford's experiments it was arranged that the α-particles could be fired through a gas at low pressure exposed to an electric field somewhat below the sparking value. In this way, the small ionisation produced by one α-particle in passing along the gas could be magnified several thousand times. The sudden current through the gas due to the entrance of an α-particle into the testing vessel was thus increased sufficiently to give an easily measurable movement of the needle of an ordinary electrometer. The apparatus and method of procedure is described at length, and results are given for several substances. In the course of the experiments it was verified that (1) for a given intensity of radiation at a given distance, the average number of throws observed in the electrometer in a given interval is independent of the pressure or nature of the gas, and also of the magnification of the ionisation ; (2) the number of α-particles entering the aperture used is proportional to the activity of the source measured by the γ-rays, and is inversely proportional to the square of the distance of the source from the aperture over the range examined—875 to 100 cm. ; (3) using RaC as a source of rays, the α-particles are, on an average, projected equally in all directions. After making some small corrections, it was found that the number of α-particles emitted by 1 gm. of radium per sec. is $3{\cdot}4 \times 10^{10}$. A separate method of counting by means of the scintillations produced on a screen of zinc sulphide gave practically the same result, showing that within the limits of experimental error, each α-particle produces a scintillation. It was also found that the distribution of the α-particles in time is governed by the laws of probability. Further work is in progress. A. W.

1628. *Charge and Nature of α-Particle.* **E. Rutherford** and **H. Geiger.** (Roy. Soc., Proc. Ser. A. 81. pp. 162–173, Aug. 27, 1908.)—Knowing the number of α-particles expelled per sec. per gm. of radium, the charge carried by each particle can be determined by measuring the total charge carried by the α-particles expelled per sec. from a known quantity of radium. In the experiments described in the present paper the same general method was used as employed previously by Rutherford [Abstract No. 1881 (1905)], with certain modifications rendered necessary by the choice of RaC as a source of α-rays. The value finally obtained for the positive charge E carried by an α-particle is $9{\cdot}3 \times 10^{-10}$ electrostatic unit. Evidence is next given, based on radio-active data, which indicates that the α-particle carries a charge $2e$, and that the ordinarily accepted values of e are somewhat too small. The value of E is first calculated on the assumption that the heating effect of radium is a measure of the kinetic energy of the α-particles expelled from it, for which there is considerable indirect evidence. The result obtained is $E = 9{\cdot}1 \times 10^{-10}$ E.S. unit. A second value $8{\cdot}2 \times 10^{-10}$ is deduced from the period of transformation of radium, which Boltwood has found to be about 2,000 years. The methods of determining the value of e are discussed, and it is concluded that the value is not very different from $4{\cdot}65 \times 10^{-10}$ E.S. unit. The atomic data deduced from the above are : Charge carried by a hydrogen atom $= 4{\cdot}65 \times 10^{-10}$ E.S. unit. Charge carried by an α-particle $= 9{\cdot}3 \times 10^{-10}$ E.S. unit. Number of atoms in 1 gm. of hydrogen $= 6{\cdot}2 \times 10^{23}$. Mass of hydrogen atom $= 1{\cdot}61 \times 10^{-24}$ gm. Number of molecules per c.cm. of any gas at standard pressure and temperature $= 2{\cdot}72 \times 10^{19}$. From consideration of the value of e/m for the α-particle the value 3·84 is deduced for the atomic weight of an α-particle. The atomic weight of the helium atom is 3·96. Hence it is concluded that the α-particle, after it has lost its positive charge, is a helium atom. In conclusion, calculations are made of various radio-active data. A. W.

1629. *Scattering of α-Particles by Matter.* **H. Geiger.** (Roy. Soc., Proc. Ser. A. 81. pp. 174–177, Aug. 27, 1908.)—Experimental evidence is here given to show that there is a very marked scattering of the α-rays in passing through matter, whether gaseous or solid. The experiments are being continued with all substances for which it is possible to get thin samples, in the hope of establishing some connection between the scattering power and the stopping power of these materials. A. W.

1630. *Decay of Radium Emanation dissolved in Water.* **R. B. Moore.** (Roy. Soc., Proc. Ser. A. 80. pp. 597–598, June 20, 1908.)—Cameron and Ramsay's results [Abstract No. 140 (1908)] admit of two possible explanations: (1) The one advanced by these authors; (2) the α-particle is a helium atom under ordinary conditions, but when the emanation is dissolved in water or copper sulphate solution an α-particle of greater mass is split off from the emanation atom. If this later explanation be correct, the disintegration products of the emanation when it is dissolved in water or copper sulphate solution should be different from those obtained from the emanation when alone or mixed with air. The author finds that the half-time period for the emanation dissolved in water is 3·8 days, so that it may be assumed that the emanation decays at the same rate when dissolved in water as in air. This result does not point definitely to either of the two possible theories mentioned above. T. H. P.

1631. *Determination of Radium Emanation.* **G. C. Ashman.** (Amer. Journ. Sci. 26. pp. 119–122, Aug., 1908.)—Eve has previously determined the amount of radio-active matter in the atmosphere by collecting the active deposit on a charged wire placed in a cylinder of known volume [Abstract No. 1738 (1905)]. The amount of pure radium necessary to keep the emanation constant varied from 82×10^{-12} to 287×10^{-12} gm. per m.^{3}. Subsequent experiments by the same author [Abstract No. 417 (1908)] emphasised the objections to the active-deposit method. The max. values were sixteen times the minimum, and, furthermore, this method does not furnish direct proof of the presence of radium emanation. Eve has recently determined directly the amount of radium emanation in the atmosphere by a new method depending on Rutherford's discovery that radium emanation is readily absorbed by specially prepared cocoanut charcoal. The max. values obtained by the absorption method were seven times the minimum, ranging from 18×10^{-12} to 127×10^{-12} gm. of radium per m.^{3} of air, the probable average value being 80×10^{-12}. In the present paper experiments are described in which the amount of emanation was determined by condensation. Air was drawn from out-of-doors at ground-level and was passed through a purification train. It then entered a coil of copper tubing immersed in liquid air, and was finally collected in aspirators of known capacity. At the end of about 6 hours the coil containing the condensed emanation was allowed to heat up and the volatilised emanation transferred to a standardised gas electroscope. The standardisation was effected by the method of McCoy and Ross, which consisted in observing the rate of discharge caused by the emanation from a portion of a mineral containing a known amount of uranium. The amount of radium associated with 1 gm. of uranium in a mineral was taken as $3{\cdot}4 \times 10^{-7}$ gm. The results of four experiments calculated on the basis of the amount of radium necessary to maintain the emanation constant in 1 m.^{3} of air were: (1) 86×10^{-12} gm.; (2) 58×10^{-12} gm.; (3) 45×10^{-12} gm.; (4) 200×10^{-12} gm. These results show a considerable variation in the amount of emanation in the air at different times; similar variations were found by Eve by both methods. In order to show that in the present case the variations were not due to incomplete condensation of the emanation a second coil of tubing similar to the first was joined up in series and the air passed through both. The emanation in the first coil corresponded to 51×10^{-12} gm. radium per m.^{3}. The second coil did not contain a trace of emanation. The mean of all the experiments was 96×10^{-12} gm., or nearly 10^{-10} gm. per m.^{3} This is about 25 per cent. higher than the mean value found by Eve. The difference may easily be due to variations in the quantity measured. Neither method is, however, entirely above criticism. A complete study was made of the activity curve of the emanation collected in experiment (4), which proved it to be identical with that of the radium emanation. The activity reached the max. value in about 3 hours after introduction into the electroscope, and decreased in the usual way to half-value in about 3·5 days. A. W.

1632. *Absorption of Radio-active Emanations by Charcoal.* **R. W. Boyle.** (Amer. Electrochem. Soc., Trans. 13. p. 429, 1908.)—Charcoal, especially cocoanut charcoal, readily absorbs radio-active emanations. The amount of absorption depends on: (1) the nature of the charcoal used, being greatest for cocoanut, less for animal, and least for wood charcoal; (2) the extent of the absorbing surface, with which it increases; (3) the temperature of the charcoal, lowering of the temperature causing increase in the absorption; (4) the velocity of the current of gas conducting the emanation through the charcoal, being greatest for the lowest speeds. T. H. P.

REFERENCES.

1633. *New Half-shadow Polarimeter.* **L. Zehnder.** (Ann. d. Physik, 26. 5. pp. 985–997, Aug. 25, 1908.)—An explanatory paper on the construction and manipulation of a polarimeter, containing a polarising nicol, a compensator and an analysing nicol combined with a smoked-glass plate, for the purpose of examining the polarisation produced by reflection. For measurements with elliptically polarised light the author considers the instrument more accurate than the ordinary Babinet or Soleil-Babinet compensator combined with an analysing nicol. G. E. A.

1634. *Absorption of Solar Radiation by Water.* **W. Schmidt.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 237–253, Feb., 1908.)—Measurements of the varying absorptions on different spectrum regions of definite amounts of water which the light is made to traverse. C. P. B.

1635. *Stationary Light-waves and Diffraction Gratings.* **E. Lohr.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 299–309, Feb., 1908.)—A mathematical theory of the phenomena concerned, and which may be regarded as an extended and more rigorous treatment of the problem on the basis of the principle used by G. Tammann in his *Electricity and Light*, 1902. E. H. B.

1636. *Photographic Solarisation.* **A. P. H. Trivelli.** (Zeitschr. wiss. Phot. 6. pp. 197–216, May; 237–257, and pp. 273–299, July, 1908. Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 2–29, Sept. 8, 1908.)—*Résumé* and discussion: nomenclature; Herschel-effect, Clayden-effect; form of picture-deposit in the film; the same in reversed copies; solarisation in bichromated film; fog in solarisation; theory of retarded development in solarisation; Sabatier's polarisation; partial disappearance of image through feeble illumination during development; theory of latent image; influence of liberated halogens; silver sub-haloids; action of sensitisers; gradation in Röntgenographs. A. D.

1637. *One-exposure Three-colour Camera.* **C. E. K. Mees.** (Photographic Journ. 48. pp. 276–279; Discussion, pp. 279–282, July, 1908.) A. D.

1638. *A General Formula for Dispersive and Resolving Powers.* **L. P. Sieg.** (Phys. Rev. 27. pp. 61–64, July, 1908.)—Develops a general formula for the resolving power, which includes prisms, diffraction gratings, and echelon gratings as special cases. L. H. W.

1639. *Quantitative Indications of Spectra: Silver.* **A. de Gramont.** (Comptes Rendus, 147. pp. 307–309, Aug. 3, 1908.)—A study of the persistence of silver lines in the spectra of argentiferous galenas compared with those of certain lead-silver and tin-silver alloys of known composition. Self-induction was employed which removes the sulphur lines. The method with certain precautions can be used for the estimation of silver in galena. Selenides and tellurides were also tried with equal success. [See Abstract No. 1528 (1907).] E. C. C. B.

1640. *Variations in the Decay of Phosphorescence in Sidot Blende produced by Heating.* **C. A. Pierce.** (Astrophys. Journ. 26. pp. 312–330, April, 1908.)—A quantitative study of the phosphorescence and thermo-luminescence of Sidot blende between 15° and 300°. The powdered blende was contained in a shallow tin dish, and the phosphorescence was excited by light from a mercury lamp. The powder was heated by a small electric furnace, the temperature being measured by a thermo-couple. The intensity of the phosphorescent light was compared with an acetylene standard by means of a Lummer-Brodhun photometer. Curves expressing the results obtained are given in the paper. E. C. C. B.

1641. *Studies in Thermo-luminescence.* II. *Variations in the Decay of Phosphorescence in Balmain's Paint produced by Heating.* **C. A. Pierce.** (Phys. Rev. 26. pp. 454–469, June, 1908.)—A complete study of the decay of phosphorescence of calcium sulphide at various temperatures and with various periods of excitation. The same apparatus and method were employed as in a previous investigation upon Sidot blende [see preceding Abstract]. Full curves accompany the paper. E. C. C. B.

1642. *Fluorescence and Photo-electric Sensibility of Organic Substances.* **J. Stark** and **W. Steubing.** (Phys. Zeitschr. 9. pp. 481–495, Aug. 1, and pp. 661–669, Oct. 15, 1908.)—The work is an extension of that described in Abstract No. 1087 (1908). The original should be consulted for the lengthy tables given.

1643. *Radio-activity of Potassium and other Alkali Metals.* **J. C. McLennan** and **W. T. Kennedy.** (Phil. Mag. 16. pp. 377–395, Sept., 1908. Phys. Zeitschr. 9. pp. 510–512, Aug. 1, 1908.)—The full paper corresponding to Abstract No. 1101 (1908).

1644. *Distribution of Rays near Radio-active Bodies.* **H. W. Schmidt.** (Phys. Zeitschr. 9. pp. 537–541, Aug. 15, 1908.)—The author criticises Greinacher's explanation of the phenomena observed [see Abstract No. 1266 (1908)] and shows that all the phenomena can be satisfactorily explained by means of Lambert's cosine law, of the truth of which they give a direct demonstration. A. W.

1645. *Ionisation in Closed Vessels.* **W. W. Strong.** (Phys. Rev. 27. pp. 39–60, July, 1908.)—A fuller account of the work described in Abstract No. 684 (1908).

HEAT.

1646. *Saturation Vapour Pressure of Water between 50° and 200° by the Platinum Thermometer.* **L. Holborn** and **F. Henning.** (Ann. d. Physik, 26. 5. pp. 833–883, Aug. 25, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The temperatures at which the vapour pressure was measured are on the thermodynamic scale, and are based on measurements with platinum thermometers compared with the nitrogen thermometer at 150° and 200°. For fixing the temperature scale of the Pt-thermometers, the boiling-points of naphthalene, benzophenone, and sulphur were observed, and the variation of the sulphur point determined for pressures between 660 and 860 mm. of Hg, the boiling-point being expressed by the quadratic formula—

$$t = 445{\cdot}00 + 0{\cdot}0912\,(p - 760) - 0{\cdot}000042\,(p - 760)^2.$$

Numerous tables are given of the observations of vapour pressure, and the values are compared with those calculated from Thiesen's formula and with those of Regnault, with which latter they are in good agreement, the variations being of the order of 0·02°. The paper, which concludes with a table of the vapour pressures for each degree between 0° and 200°, is illustrated with figures of the apparatus and a curve. G. E. A.

1647. *Latent Heat of Vaporisation of Metals and other Substances.* **J. W. Richards.** (Amer. Electrochem. Soc., Trans. 13. pp. 447–451, 1908.)—It is first pointed out that solid metals near their melting-points have sp. heats 50 to 100 per cent. greater than between 0 and 100°. The probable value of the Dulong and Petit constant is calculated from the most reliable data for the common metals to be 6 at the absolute zero and 10 at the melting-points of the metals. 1,698 cals. are required to raise at. wt. of metal from absolute zero to centigrade zero. The mean value of the atomic sp. heat from absolute zero to the melting-point T is 8 cals., and the total heat in the solid metal at its melting-point is 8T cals. The latent heat of fusion of at. wt. of a metal has previously been shown by the author to be a function of the absolute temperature of the melting-point and to be approximately 2T. The total heat in melted metal at the melting-point will be 8T + 2T = 10T cals. The sp. heats of liquid metals are practically equal to the sp. heats of the solid metals at their melting-point. The heat required to raise the liquid metal from the melting-point T to the boiling-point to T′ is 10(T′ − T), and the total heat in the liquid metal at the boiling-point is 10T′. The heat absorbed in volatilising a substance is a function of the absolute temp. of the boiling-point T′. Trouton showed that the latent heat of vaporisation for mol. wt. in gm. is approximately 23T′ at constant atmospheric pressure, and the total heat in mol. wt. of a metal as vapour at its normal boiling-point is 33T′; reckoned from 0° C. this is 33T′ − 1700. Table I. shows the values obtained for metals and Table II. for non-metals; in this case determined values are given for comparison with calculated values:—

TABLE I.

Metal.	At. Wt.	Boiling-point. C°.	Boiling-point. T'. (abs.)	23 T'.	Latent Heat of Vapour per 1 kg.	33 T' −1700.	Total Heat in 1 kg. Vapour to 0° C.
Hg	200	357	630	14,490	72·5	19,090	95·5
K	39	720	993	22,840	586	31,070	797
Cd	106	778	1,051	24,170	228	33,000	311
Na	23	900	1,173	26,980	1,173	37,000	1,609
Zn	65	930	1,203	27,670	426	38,000	585
In	—	1,000	1,273	29,280	—	40,300	—
Mg	24	1,100	1,373	31,580	1,316	43,600	1,817
Te	127	1,390	1,663	38,250	301	54,880	432
Bi	208	1,435	1,708	39,280	189	56,360	271
Sb	120	1,600	1,873	43,080	359	60,110	509
Tl	204	1,700	1,973	45,380	222	63,410	311
Pb	207	1,800	2,073	47,680	230	66,710	324
Ag	108	2,040	2,313	53,200	493	74,630	691
Cu	63·5	2,100	2,373	54,580	860	76,610	1,206
Sn	118	2,170	2,440	56,120	476	78,820	668
Mn	55	2,200	2,473	56,480	1,027	79,510	1,445
Ni	59	2,325	2,598	59,750	1,013	84,030	1,424
Cr	52	2,365	2,638	60,670	1,167	85,350	1,641
Fe	56	2,420	2,693	61,940	1,106	87,170	1,555
Pt	197	2,450	2,723	62,630	318	88,160	447
Ti	48	2,475	2,748	63,200	1,317	88,980	1,854
Rh	103	2,500	2,773	63,780	619	89,810	872
Ru	102	2,515	2,788	64,120	629	90,300	883
Au	197	2,530	2,803	64,470	327	90,800	461
Pd	106·5	2,535	2,808	64,580	606	90,960	854
Ir	193	2,545	2,818	64,810	336	91,290	473
Os	191	2,600	2,873	66,080	346	93,110	487
U	239	2,900	3,173	72,980	305	103,010	431
Mo	96	3,200	3,473	79,880	832	112,910	1,176
W	184	3,700	3,973	91,380	497	129,410	703

TABLE II.

Formula.	Mol. Wt.	Boiling-point. C°.	Boiling-point. T'. (abs.)	23T'.	Latent Heat of Vapour per 1 kg.	Experimentally Determined.
H^2	2	−253	20	460	230	—
N^2	28	−196	77	1,771	63	50
O^2	32	−188	85	1,955	61	58
Cl^2	71	−22	251	5,773	81	67
Br^2	160	58	331	7,613	48	46
I^3	381	174	447	10,280	27	24
P^3	93	287	560	12,880	138	130
As^3	225	450	723	16,629	74	—
Se^3	237	690	963	22,150	94	—
B^2	22	3,700	3,973	91,380	4,154	—
C^2	24	3,700	3,973	91,380	3,808	—

C. O. B.

1648. *Specific Heats of Conductors at different Temperatures.* **E. Lecher.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 111–141, Jan., 1908. From the Physikal. Inst. d. k.k. deutsch. Univ., Prag.)—By many methods of measuring the Thomson-effect and some for the Peltier-effect a knowledge of the relation between specific heat and temperature is required. The author accordingly undertook the determination for certain electric conductors. The temperatures were read by a Pt-Rh-Pt thermo-element, and the metal under test was in a vacuum in a porcelain tube. The chief results are briefly as follows: With nickel *in vacuo* the specific heat increases by about 50 per cent. from ordinary temperatures to 350° C., and then falls sharply and remains nearly constant at 700° at a value about 30 per cent. greater than at room temperatures. For iron *in vacuo* the specific heat rises gradually and uniformly for ordinary temperatures to a little over 700°, increasing about threefold throughout this range. Between 700° and 950° the value of the specific heat falls, its final value being only about double that at ordinary temperatures. E. H. B.

1649. *General Law for Vapour Pressures.* III. *Vapour Pressure of Carbon Dioxide.* **S. A. Moss.** (Phys. Rev. 26. pp. 439–447, June, 1908.)—The general law for vapour pressures discussed previously [see Abstract No. 819 (1908)] is applied to the observations of vapour pressure of solid and liquid CO_2 made by Zeleny and Smith [see Abstracts Nos. 1887 and 2048 (1906)]. Very good agreement is found for vapour pressures of both solid and liquid. On the basis of these results and by applying the Roche law given by Regnault as "Formula K" for the pressure of water vapour, saturation-pressure equations are deduced which represent with reasonable accuracy the observations for pressures varying from about 1 mm. of mercury through the triple point to the critical pressure of 55,000 mm. T. H. P.

1650. *Radiation from the Nernst Glower.* **W. W. Coblentz.** (Bureau of Standards, Bull. 4. pp. 533–551, May, 1908.)—The distribution of the radiant energy from a Nernst glower is determined at different energy consumptions, and hence at different temperatures. The apparatus used comprised a spectrometer, having mirrors 10 cm. in diam. and 50 cm. focal length, a clear fluorite prism with an angle of 60° and circular faces 33 mm. in diam., and a bolometer with a hemispherical reflecting mirror. The bolometer and spectrometer slits were each 0·6 mm. wide. The collimating mirrors and the Wadsworth mirror-prism table in the upper part of the spectrometer were entirely enclosed by a thin sheet-metal box lined with black velvet. Within this box were placed vessels containing phosphorus pentoxide and sticks of potassium hydroxide so as to eliminate the absorption bands of CO_2 and water vapour from the emission curves. The time of swing of the auxiliary galvanometer was 5 sec. and the current sensibility was $1{\cdot}5 \times 10^{-10}$ amp. By varying the energy consumption from 16 watts—the lowest at which the glower would conduct without using a transformer—to 123 watts, which is far above normal, a series of energy curves are obtained. The energy curves are continuous, but undergo great variations in appearance with rise of temperature. At 2·5 and 3·5 μ, elevations and depressions generally appear on the curves. These results are entirely different from anything hitherto observed. At the lowest temperature (800°–900° C.) the glower was a greyish red and the bands in the region of long wave-lengths are the most intense. The emission-curves of a 110-volt glower at 17 and 21·8 watts respectively are compared with "black body" radiation. The curves have two maxima values at 1·4 and 5·5 μ respectively. The emission-curves of a 200-volt filament are given at 15·8, 17·6, 19·2, 22·1, 27·1, 34·6, 52·7, and 62·4 watts respectively. At the lower temperatures there is an emission minimum at 4 μ, but this disappears at the higher temperatures. The radiation curve of the 220-volt filament at a very high temperature is obtained. The emissivity decreased rapidly in intensity, probably due to the evaporation and decrease in diam. of the filament. The results indicate that the emissivity is abnormally increased in the visible part of the spectrum. The theoretical curve of a "black body" having a max. emission coinciding with that of the glower at 1·3 μ (t = 1,975° C.) falls below the observed curve in the visible part of the spectrum and is higher than the observed curve at 5 μ. Exactly opposite effects were observed at 16·8 watts. The results prove that even after the emission spectrum has become apparently continuous it does not follow the simple law which has been proved for solids emitting continuous spectra. Any estimations, therefore, of the temperature of the glower based on these laws must lead to erroneous results. From a commercial point of view the efficiency of such a radiator—in which the emissivity is abnormally high at 0·6 to 0·7 μ, while the max. at 1·2 μ is abnormally low—must be much higher than that of substances having a radiation law similar to that of Pt, in which case the max. at 1·2 μ is excessively high when the intensity over the visible spectrum is similar to that of the Nernst glower. In a subsequent paper the selective emission of the Nernst glower will be further considered, and the manner in which some of the emission bands are suppressed whilst others are intensified in different substances will be described. A. R.

REFERENCES.

1651. *Thermal Radiation at very Low Temperatures.* **J. T. Bottomley** and **F. A. King.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 349–379, July 27, 1908.)—A fuller account of the previous work [Abstract No. 1175 (1907)]; the temperature range has also been extended by the use of liquid air to cool the enclosure. Some new results are given and compared with those of previous workers and with Stefan's formula. L. H. W.

1652. *Standardisation of the Fog Chamber.* **C. Barus.** (Amer. Journ. Sci. 26. pp. 87–90, July, 1908.)—Note on a method of evaluating the coronas in terms of the number of nuclei which they represent under given conditions of exhaustion by the aid of Thomson's electron, using the determined value of e. J. J. S.

1653. *The Nadir of Temperature and Allied Problems.* **J. Dewar.** (Engineering, 85. pp. 793–794, June 12, 1908. Discourse delivered at the Royal Institution, June 5, 1908.)

1654. *Inversion Temperatures and Equation of State.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 28. pp. 394–399, 1908.)—A mathematical paper, which cannot satisfactorily be abstracted. F. J. B.

1655. *Entropy.* **Auric.** (Comptes Rendus, 146. pp. 891–892, April 27, 1908. Extract.)—The differential coefficient ds/dv, where s is entropy, is equated with the ratio of the densities of ether and matter respectively. E. E. F.

1656. *Theoretical Estimation of the Vapour Pressure of Solid and Liquid* CO_2. **E. Falck.** (Phys. Zeitschr. 9. pp. 433–440, July 1, 1908. Phys. Inst. der böhmischen techn. Hochschule.)—Tests a formula given by Nernst; good agreement with known experimental results is found. R. S. W.

SOUND.

1657. *Intermittence-Tone Phenomena reconciled with Helmholtz's Resonance Theory.* **F. A. Schulze.** (Ann. d. Physik, 26. 7. pp. 217–284, June 9, 1908.)—The perception by the ear of a tone of the frequency of an intermittence of another higher tone or of a variation in its amplitude has been recognised by a number of authorities, but thought incompatible with the Helmholtz resonance theory of the action of the internal ear. The present author takes the opposite view, and while supporting the reality of the "intermittence" or "variation" tone, considers it reconcilable with Helmholtz's theory in the following way: Let a tone of frequency p have its amplitude A intermitted or varied with a frequency u. Thus in either case A may be expanded by Fourier's series in the form—

$$A = a_0 + a_1 \sin(2\pi ut + \delta_1) + a_2 \sin(2\pi . 2ut + \delta_2) + \dots$$

The aerial vibrations are accordingly denoted by—

$$\begin{aligned} A \sin(2\pi pt + \epsilon) &= a_0 \sin(2\pi pt + \epsilon) + a_1 \sin(2\pi pt + \epsilon) \sin(2\pi ut + \delta_1) \\ &\quad + a_2 \sin(2\pi pt + \epsilon) \sin(2\pi . 2ut + \delta_2) + \dots \\ &= a_0 \sin(2\pi pt + \epsilon) + \frac{a_1}{2} \cos[2\pi(p - u)t + \epsilon - \delta_1] - \frac{a_1}{2} \cos[2\pi(p + u)t + \epsilon + \delta_1] \\ &\quad + \frac{a_2}{2} \cos[2\pi(p - 2u)t + \epsilon - \delta_2] - \frac{a_2}{2} \cos[2\pi(p + 2u)t + \epsilon + \delta_2] + \dots \end{aligned}$$

There are accordingly objective tones of the frequencies p, $p - u$, $p + u$, $p - 2u$, $p + 2u$. And from these may be formed the combinational tones (possibly subjective) of frequencies u, $2u$, $3u$, ..., $2p + u$, $2p + 2u$, ..., &c. Schulze prefers to call the above objective tones *variation tones of higher order.* Experiments in confirmation of these views are also cited.

E. H. B.

1658. *Direction of Submarine Signals.* **L. Zehnder.** (Phys. Zeitschr. 9. p. 519, Aug. 1, 1908.)—An apparatus is suggested, the function of which is to detect the direction from which a submarine sound signal comes. It consists of a vertical rod with a horizontal cross-piece, at the ends of which two similar telephones or microphones are fixed with the same orientation, the distance between the two receivers to be half a wave-length of the signalling note. The two receivers being connected in series and in circuit with another telephone are placed under water, and, on the vertical rod being rotated once, two maxima and two minima would be perceived. The required direction is that of the cross-piece when the minima are observed. A motion of the ship or apparatus would be necessary to decide from which point the sound comes.

G. E. A.

REFERENCE.

1659. *Photographic Registration of Sounds.* **Georges Laudet** and **Gustave Laudet**. (Comptes Rendus, 146. pp. 1311–1314, June 22, 1908.)—Some curves of the sounds of ordinary speech are reproduced. These are obtained mechanically without the intervention of microphone currents, and they render the slightest sibilant sounds, which the microphone suppresses. The records are remarkably clear. [See Abstract No. 2231 (1905).]

E. E. F.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1660. *Molecular Attraction for Electrical Double Points.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 182–188, Sept. 8, 1908.)—Several physicists have already urged the supposition that the molecular attraction results from the electric forces exercised by electrically charged particles which are contained in the molecule. One of the simplest suppositions used in trying to explain the molecular action by an electrical method is that the molecules behave as electrical double points. This has been assumed by M. Reinganum and by W. Sutherland. As the formula for the action between two electrical double points (like that for the action between two magnetic molecules) contains $1/r^4$ as a factor, r being the distance between the two double points; these physicists concluded that the molecules would attract one another with a force proportional to $1/r^4$. The opinion that the electron theory supports this law of molecular attraction has accordingly been often advanced. On closer inspection, however, this opinion proves to be unfounded. If the double points have not yet yielded to the directing couples which they exercise on one another, and if therefore the axes may be directed in any direction, the mutual action will as often be a repulsion as an attraction, *i.e.*, the mean attraction will be zero. If, on the other hand, we might assume that they had perfectly yielded to the directing couples they would attract each other with forces proportional to $1/r^4$. It is, however, evident that the molecules will have yielded only partially to the couples, and that they will be more perfectly directed according as they have approached each other more closely, and therefore lie in a stronger field of force. The consequence will be that the resulting molecular action will be an attraction which with increasing r varies more rapidly than $1/r^4$. Reinganum and Sutherland each noticed this, but thought the attraction law would deviate but slightly from $1/r^4$. The present author finds that the lowest degree of $1/r$ which occurs in the series representing the attractive force is the seventh, therefore the force varies more rapidly than proportional to $1/r^7$, as surmised by him in 1900. E. H. B.

1661. *Ionisation of Air.* **H. Schering.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 201–218, 1908.)—The author has previously described measurements of the specific conductivity of air [Abstract No. 1270 (1906)]. In order to find how the conductivity depends on the meteorological conditions, it is desirable to have some registering instrument for the measurements. Such apparatus, and the method of use, is here described. The ionising body was a thin horizontally stretched wire, the other electrode being a concentric cylinder of wire-gauze. Special insulation was used, and the wire was charged to a potential of + 140 volts. The electrometer used was an Elster and Geitel quadrant electrometer of modified form. The capacity of the electrometer was found, by two methods, to be 11·0 and 11·1 cm., and the loss of potential when charged was about 4 volts per hour. The loss of charge from the ionising apparatus was very small with a positive charge, but with the wire charged negatively there was a loss of about 10 per cent. per min. The registering of the potential-fall was obtained by focussing a ray of light from the electrometer on to a slowly revolving cylinder carrying a sheet of sensitised paper, the cylinder making one complete revolution in 24 hours. The deflections were standardised by means of a cell of uranium nitrate, so that absolute measurements of the specific conductivity were obtained. Specimen curves for the potential-fall and also for the conductivity of the air are given. A. W.

DISCHARGE AND OSCILLATIONS.

1662. *Ionised Gases.* **A. Blanc.** (Comptes Rendus, 147. pp. 39–42, July 6, 1908.)—Measurements of the mobilities of the ions in mixtures, at constant pressure, of air with CO_2 and of CO_2 with hydrogen. The curves representing the reciprocals of the mobilities as functions of the pressure of one of the two gases in the mixture are straight lines in all cases. The mobility in air of an ion, of either sign, produced in CO_2 is very precisely the same as if this ion had been produced in air. This might be explained by the large size of the ions, or by the group which constitutes the ion having exchanged its molecules for others from the second gas. A. D.

1663. *Positive Electrons?* **A. Bestelmeyer.** (Phys. Zeitschr. 9. pp. 541–542, Aug. 15, 1908. Physikal. Inst. d. Univ., Göttingen.)—The author discusses J. Becquerel's papers upon the existence of positive electrons [Abstract No. 1468 (1908)], and says that the evidence for their existence is erroneous. He points out that in Becquerel's experiments the canal rays and kathode rays passed through a very narrow orifice and that the walls at the narrow orifice became negatively charged by the kathode rays. The charged walls then exerted an attractive force upon the canal rays so that they were deviated. E. C. C. B.

1664. *Effect of Invisible Radiations on the Explosive Discharge in Air.* **I. Schincaglia.** (N. Cimento, 15. pp. 481–491, June, 1908.)—The author has compared the length of spark produced by a spark-gap when subjected to the invisible radiation from a second spark with that of the spark when these radiations are shut off. Under certain conditions the length of spark has been increased by the radiation to as much as 5 times its normal length. The resistance of various transparent bodies and solutions to the passage of the radiation has been compared, nitric acid, a 10 per cent. solution of $CuSO_4$, and benzene showing the greatest absorption, and water and absolute alcohol the least. [See Abstract No. 2959 (1904).] W. H. Sı.

1665. *Constitution of the Electric Spark.* **T. Royds.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 333–347, July 25, 1908.)—A repetition of Schuster and Hemsalech's experiments upon the photography of the electric spark with a rapidly moving film. The apparatus was essentially the same as that used in the earlier experiments, but the optical arrangements were much improved and better definition was obtained. It was found that the same velocity was not observed with all the lines of the same spectrum, but they may be broadly divided into two classes—long lines indicating the normal velocity and short lines indicating a greater velocity. While the former may be explained by diffusion of the luminous vapour the latter is too great to be due solely to this cause. In some cases the envelope indicating the velocity of the vapour was sinuous, indicating that the particles are in these cases charged. The velocity is apparently dependent upon the amount of metal vapourised and is generally less for metals of higher boiling-point. The streamers start at both electrodes, but are stronger when the electrode is negative, except the first streamer from the initially positive electrode. The streamers from the positive electrode are rarely seen in the lines of longer duration. E. C. C. B.

1666. *Structure of the Electric Arc.* **W. B. Huff.** (Astrophys. Journ. 28. pp. 59–65, July, 1908.)—Previous work has been done by examining a series of images of the electric arc, using a flat diffraction grating, and the results showed marked differences between the various parts of the arc. The structure varies according to whether positive or negative is uppermost in the case of a vertical arc. Examination with a rotating mirror has not resulted in the detection of any discharge which was strictly oscillatory. It may under certain conditions be explosive, however, giving quite regular interruptions in the progress of discharge. In appearance the positive and negative discharges from a metal arc are quite different, and each is deflected by a weak magnetic field, the direction being that which would be shown by a stream of charged particles. Examining the separate images with a diffraction grating, it was found that the magnetic field deflects all parts of the negative discharge to the same extent. It is surmised that the velocity of the charged particles emitted by the arc discharge is extremely low compared with that of the particles associated with the discharge in a vacuum tube. [See Abstract No. 1086 (1908).] C. P. B.

1667. *Short Spark Phenomena.* **W. Duddell.** (Phil. Mag. 16. pp 840–845, Aug., 1908. Paper read before the Physical Soc., April 10, 1908. Electrician, 61. pp. 184–185; Discussion, p. 185, May 8, and pp. 796–797, Sept. 4, 1908. Abstract.)—Two curious effects are described which were observed during the use of a 12-in. induction coil supplied from the 200-volt direct-current mains, a large resistance being in series with the primary and the current being interrupted by means of a mercury-jet interrupter. When there was no spark-gap in the secondary circuit the mean current as read by a moving-coil galvanometer in the circuit was zero, and the R.M.S. current measured by a thermo-ammeter had a value of about 8·8 milliamps. On introducing a microscopic spark-gap into the secondary circuit two effects were observed. (1) The R.M.S. current increased enormously in value; and (2) a very large deflection was produced on the galvanometer measuring the mean current, and this deflection was in the direction corresponding to making the primary circuit. On introducing a spark-gap $\frac{1}{10}$ mm. long the R.M.S. current instantly rose from 8·8 to 88·5 milliamps. and continued to increase with increasing spark-length until it reached a maximum at a spark-length of about 1·4 mm. From 1·6 to 5 mm. spark-length the R.M.S. current gradually fell in value, and attained a minimum value of 10·5 milliamps. Further increase in spark-length produced a gradual increase in the R.M.S. current up to the maximum length of 15 mm. that was used. The author considers the effect to be due to very high frequency oscillations being set up in the wires connected to the secondary circuit of the coil when a spark-gap is introduced. The magnitude of the oscillations depends on the voltage between the terminals of the spark-gap just before the spark passes and on the resistance of the spark-gap. On increasing the length of the spark, the p.d. between the terminals increases and also the resistance, so that two conflicting agencies are at work, one tending to increase and the other to decrease the magnitude of the oscillatory current. This differential action would account for the shape of the curve showing the relation between current and spark-length. The large deflection on the galvanometer—effect (2)—was investigated by recording the wave-forms of the p.d. and the current by means of an oscillograph. Figures showing some of the typical results are given in the paper. J. J. S.

1668. *Production of Phase-displaced High-frequency Currents.* **H. Diesselhorst.** (Deutsch. Phys. Gesell., Verh. 10. 14. pp. 546–549, July 30, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—The author points out that though it is easy to obtain phase-displaced currents of 90° by an inductive coupling of two tuned circuits, as is well known, the coupling must be loose, which means little energy can be transferred, or else with closer coupling the two waves inherent to such coupling appear and the phase-displacement cannot be obtained. He gives a method of overcoming this drawback. This consists in the employment of two loosely coupled tuned oscillatory circuits, each having a generator (Poulsen arc, for instance). Each circuit in this case receives energy from its own generator, and the coupling only serves to keep the currents at the same frequency and in quadrature. As to which current precedes the other, this depends on the ignition of the arcs and the closing of the circuit. When out of tune, the phase-difference rapidly disappears, so that the setting-in of the 90°-displacement can be used as a means of tuning. With this arrangement experiments with the Braun tube can be carried out still better than with spark discharges, owing to the intensity and continuity of the fluorescent image produced. A break or intermittence in the oscillations is noticeable at once. An alternative method is also described, using three Poulsen lamps. With this arrangement three-phase currents can be obtained. L. H. W.

1669. *Frequency of the Singing Arc.* **G. W. Nasmyth.** (Phys. Rev. 27. pp. 117–140, Aug., 1908.)—The experiments described were for the purpose of determining the relation between the frequency and the arc-length. The experiments were made with a direct-current arc in a bronze chamber supplied with coal-gas, a wedge-shaped, water-cooled Cu anode being opposed to a revolving graphite disc as kathode. The primary inductance was 0·171 millihenry; primary capacity, 0·0094 mfd.; secondary (shunt) inductance, 0·189 millihenry; p.d. across arc (open circuit), 500 volts, calculated frequency, 125,000; current in secondary at resonance, about 10 amps. The results show that the frequency varied from 83,400 with an arc-length of 8·8 mm. (0·0186 mfd. secy. capacity) to 128,000 with an arc-length of 0·8 mm, (0·00871 mfd.). The frequency thus decreases with increasing arc-length, at first slowly and then more rapidly at arc-lengths of 3 or 4 mm. At zero arc-length the curve plotted cuts the axis of frequencies at a point corresponding to that obtained from the formula $n=(1/2\pi)\sqrt{(1/LC)}$. The frequency, further, increases with the inductance when the product CL is maintained constant; it also increases with increase of the steady current through the arc. The frequency is, however, decreased by surrounding the arc by gas instead of air, and by increasing the pressure of the air or gas. A formula for the frequency which explains all the above effects is derivable from the arc characteristic; this is, in its simplified approximate form—

$$n=(1/2\pi)\sqrt{(1/LC-d^2l^2/4L^2A^2)}.$$

As applied to practicable problems, the formula indicates that for a large change of frequency with a small change of arc current (as in wireless telephony) the inductance of the shunt circuit should be very small. For steady conditions of tuning, on the other hand, L should be large. For maximum energy in the oscillations, dV/dA should be negative and numerically large, where A is the arc-current and V the p.d. across it. The arc-length should thus be large, the arc-current small, the arc itself in gas or air under pressure, and the electrodes and enclosure of large heat capacity and good thermal conductivity. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1670. *Hall-effect in Silicon.* **Miss F. G. Wick.** (Phys. Rev. 27. pp. 76–86, Aug., 1908.)—Experiments were made with two plates of silicon, one containing 99 per cent. Si, and the other 95·80 per cent. Difficulties arose through the hardness and brittleness of the substance. It is also not easily fused, and on account of the large thermal-e.m.f. care had to be taken to prevent unequal heating. The plate tested was placed between the poles of an electromagnet in such a way that the magnetic lines of force were perpendicular to it. A strong uniform field was obtained, and the determination of its intensity was made by comparison with one of known value at the centre of a long solenoid. A current shunted from a storage battery was passed longitudinally through the plate of silicon, and a permanent e.m.f. was thus set up which had a direction perpendicular to the magnetic force and also perpendicular to the primary current in the plate. To measure the transverse current through the plate points on its margin were connected to a galvanometer circuit in such a way that the circuit included a known resistance, R_3, shunted from a standard cell circuit. The magnitude of the effect was measured by changing the resistance R_3 sufficiently to restore a balance and bring the galvanometer to rest in the position it occupied before the magnetic circuit was closed. The e.m.f. produced by the action of the magnetic field upon the current was then easily computed. The rotary power $= ed/IM$, where $M =$ strength of magnetic field, $I =$ strength of primary current, $e =$ transverse e.m.f., all in c.g.s. units; $d =$ thickness of plate in cm. The average value of the rotary coefficient of the Hall-effect for the first plate was 120·1, and for the second plate 28·0. The sign of the Hall-effect in silicon is negative according to the convention used. The rotary power is considered positive when a positive transverse current is generated in the plate in that direction in which the conducting strip tends to move under the action of the main current and the magnetic force. The direction of the effect in silicon is the same as that in gold. In order to determine the effect of temperature upon the Hall-effect in silicon, the first plate was cooled to a temperature of −100° C. and the effect compared with that at ordinary temperatures. It was found that the difference of potential due to the Hall-effect decreases as the temperature is lowered. At −100° the effect is 0·496 that at room temperature. As in the case of other substances, the behaviour of silicon indicates a close connection between the Hall-effect and thermo-electricity. Of the plates used, the first which contains the least impurity has the larger Hall-effect, indicating that the presence of foreign substances tends to diminish the effect. It has been found impossible as yet to get chemically pure silicon in quantities. J. J. S.

1671. *Contact Rectifiers of Electric Currents.* **L. W. Austin.** (Bureau of Standards, Bull. 5. pp. 133–147, Aug., 1908. Phys. Zeitschr. 9. pp. 253–256, April 15, 1908. Translation.)—The author describes a series of experiments resembling those of Pierce on carborundum [Abstract No. 1575 (1907)]. In the present work the contacts employed were silicon-steel, carbon-steel, and tellurium-aluminium; in the last case the author had previously stated the action to be a thermoelectric one [see Abstract No. 1391 (1907)]. The unilateral conductivity for direct current is shown by the tabulated results, and the observed and calculated rectified currents when alternating p.d.'s of various values are applied. With the silicon-steel contact the rectification phenomenon is extremely reproducible below 0·2 volt, and within this range (down to 0·02 volt) the rectified currents are approximately proportional to the square of the alternating voltage. With the Si rectifier the rectified current generally flows from steel to Si, but one sample shows the opposite behaviour. The carbon-steel rectification is less perfect. The Te-Al contact, while less satisfactory as regards rectification, is strongly unilateral for direct current; the rectified current at very low voltages (*i.e.*, as a wave-detector) flows in the same direction as the thermoelectric current produced by heating the contact, but at higher voltages (> 0·5 volt) has the *opposite* direction to that of the thermoelectric current as in the case of the silicon-steel and carbon-steel contacts. No explanation of the effect is given, but some speculations as to the probable cause are included. L. H. W.

1672. *Electro-capillary and Thermoelectric Phenomena in Gases.* **G. Reboul.** (Annal. Chim. Phys. 14. pp. 433–539, Aug., 1908.)—The author finds that the relation discovered by Lippmann (1875) between the capillary constant and the p.d. at the surface of contact of mercury with an electrolyte can be extended, at any rate qualitatively, to the contact of mercury with insulating liquids and gases. The results obtained are regarded as justifying the conclusion that a double layer exists at the surface of separation of a metal and any medium whatever. The charges emitted by metals heated in air at the ordinary pressure have been studied, the results obtained being analagous with those obtained in gases at low pressures. It is further shown that: (1) the fatigue exhibited by a wire is due largely to alteration of its surface; (2) the saturation current for positive charges is connected with the temperature by an exponential function, this being a direct proof of ionisation; (3) the negative charges appear at a higher temperature than the positive ones, and are always lower than the latter and increase exponentially with rise of temperature; (4) the emission of positive charges cannot be explained merely by oxidation of the metal, since it is of the same order in CO_2 as in air and seems to be weaker in oxygen; (5) among the ions produced by heated metals there are large ions analagous with those found in the atmosphere or in the gases issuing from flames. The author finally proceeds to show how the above results are explained by the electron theory of metals. At the surface of separation of metal from air there would be a double layer opposing the exit of the electrons and resulting from a dynamic equilibrium between the positively and negatively charged centres and the neutral centres resulting from their combination, this equilibrium obeying the law of Guldberg and Waage. Modification of this equilibrium would be followed by emission of charged centres into the gas and into the metal. If this modification is produced by a sudden change in the surface, electro-capillary phenomena result, whilst if it is produced by variation of temperature, thermoelectric phenomena are observed. T. H. P.

1673. *Galvanometer Scale for Thermoelectric Couples.* **A. Zeleny.** (Phys. Rev. 27. pp. 141–148, Aug., 1908.)—A method of constructing a galvanometer scale for the direct reading of temperatures with thermoelectric couples is described. Assuming that the law connecting the e.m.f. and the temperature of a thermo-couple is given by $e = at + bt^2$, where a and b are constants, we have $de/dt = a + 2bt$. The galvanometer deflections, therefore, produced per degree difference of temperature vary with the temperature. If D and D′ be the two scale deflections per degree rise of temperature when the temperatures are t and t' respectively we have $D'/D = (a + bt')/(a + bt)$ very approximately. In this manner the length of the division D′ at any temperature t' is calculated. The scale is ruled preferably on a dividing engine. The first division is made of the chosen length D, and the lengths of the succeeding divisions form an arithmetical progression, the common difference being $(D' - D)/(t' - t)$. The defects inherent in moving-coil galvanometers are, (1) the want of proportionality between the deflection and the current, (2) hysteresis, (3) thermal e.m.f. in galvanometer, and (4) temperature-coefficient of galvanometer. A method of obviating the third defect is described. A. R.

1674. *Cold-junction Correction for Thermo-couples.* **C. Offerhaus** and **E. H. Fischer.** (Electrochem. Ind., N.Y. 6. pp. 362–365, Sept., 1908.)—The true temperature of the hot-junction is not obtainable by adding the temperature as read on the galvanometer to the temperature of cold-junction, because the e.m.f. curve is not a straight line. The method is applicable however, if, instead of the temperature of cold-junction, the same multiplied by a correction factor be used. This factor depends on both the cold- and hot-junction temperatures, and on the particular couple. Examples of the values are given, and a comparison is made of the errors involved (1) by neglecting the factor, (2) using a constant factor over a certain range, and (3) using the same correction factor for all couples as found for a particular couple. For accurate measurements the e.m.f. corresponding to the cold-junction temperature is to be added to the actual e.m.f. reading, and the true temperature obtained from the calibration curve. For the usual Pt–Pt-Rh and Pt–Pt-Ir couples, a two-term parabolic formula up to 50° or 100° C. is convenient, and for the higher range the usual logarithmic formula is used. F. R.

1675. *The Seleno-Aluminium Bridge.* **G. M. Minchin.** (Roy. Soc., Proc. Ser. A. 81. pp. 9–21, July 30, 1908.)—A description of experiments made on the resistance of selenium, the bridge consisting of a narrow strip of conducting selenium connecting two surfaces of Al separated by mica. The conductivity of the bridge can be expressed as a linear function of the applied voltage. In observing the effect of intensity of light on the current, two coloured lights were used, one a pure red and the other a nearly pure blue. If i_1 be the intensity of light of wave-length λ which alters the current C_0 into C_1, and i the intensity of the same light which alters C_0 into C; then these are related by the equation: $\log(C/C_0) = (i/i_1)^{k/\lambda} \log(C_1/C_0)$, where k is a constant. The value of C/C_0 for a given intensity and colour is found to be the same, whatever the voltage. A thin coating of paraffin wax on the selenium protects it, does not diminish its sensitiveness, and seems to facilitate the return of the bridge to its natural state when the light is withdrawn. Adams and Day, using crystalline selenium with Pt electrodes, found the resistance to increase with the time of flow of the current. The reverse of this happens with the seleno-aluminium bridge, and seems to point to chemical action at the electrodes. The time-current curves were also observed and equations found for them, the current increasing to an asymptotic maximum. [See also Abstracts Nos. 267 and 1085 (1908).] G. E. A.

1676. *Electrical Resistance of Alloys.* **E. L. Lederer.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 311–318, Feb., 1908. From the physikal. Inst. d. k.k. deutsch. Univ., Prag.)—Mathiessen's researches have shown that the resistance of alloys formed of mixed crystals is greater than that calculated from the law of mixtures, and thermoelectric theories have been put forward which, however, are unable to account for the enormous increase in resistance such as in constantan (Cu 60, Ni 40 per cent.) which amounts to 2,500 per cent. Measurements of the resistance of wires of manganin, German silver, nickelin and constantan are made by the methods of the Wheatstone bridge and the Joule calorimeter, and values found by both methods agree to within 0·4 per cent. Hence the conclusion is expressed that all theories must be considered faulty which assign the great resistance of alloys to thermoelectric causes. G. E. A.

1677. *Conductivities of Metals and Alloys at Low Temperatures.* **C. H. Lees.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 381–448, July 29, 1908. Bakerian Lecture. Proc., Ser. A. 80. pp. 143–145, Feb. 18, 1908. Abstract.)—An account of the measurements of the thermal and electrical conductivities of certain approximately pure metals and alloys. The first part of the paper is devoted to the thermal conductivity measurements. The curves of results show that over the range —170° C. to +100° C., the thermal conductivity of a pure metal changes comparatively little. With most metals the conductivity decreases slightly with increase of temperature, but silver appears to have a max. conductivity at about —90° and to decrease very slightly up to +100°. Aluminium has a minimum conductivity at about —110°, and there is a slight increase in the case of nickel over the whole range —160° to +18°. All the alloys tested conduct better at high than at low temperatures. The second part of the paper deals with the electrical conductivity measurements. In it a comparison is made of the resistivities found with those found by Dewar and Fleming. The differences are not large, and as the influence of impurity on the electrical resistivities of metals is very marked at low temperatures, the comparison serves as a test of the degree of purity of the metal used. A table of values of the product of electrical conductivity into absolute temperature shows a general tendency for the product to increase with decrease of temperature, for all the metals tested except iron and nickel, and these contained a little impurity. All the alloys show a decrease of the product as the temperature decreases. In a third section, the results are compared with the electronic theories. The author points out that it is doubtful whether any theory which does not take into account the atomic differences of the various metals can give a satisfactory explanation of the whole facts. The fact that the variation of the thermal conductivities of the metals, with temperature, is of the same character as, though less marked than, the corresponding variations for electrical insulators, and that alloys vary in a manner similar to the only mixture (glass) of insulators yet investigated, both support this contention, that theories which depend solely on free electrons as carriers can hardly claim to be adequate expressions of the phenomena. F. E. S.

1678. *Influence of Humidity on Manganin Resistances.* **St. Lindeck.** (Zeitschr. Instrumentenk. 28. pp. 229–248, Aug., 1908. Communication from the Physikal.-Techn. Reichsanstalt. Electrician, 62. pp. 14–16, Oct. 16, 1908. Abstract.)—The results published confirm the view first advanced by Rosa and Babcock [see Abstract 1892 (1907)], that manganin resistances coated with shellac vary in value with the humidity of the surrounding medium. The variations observed at the Reichsanstalt are, however, smaller than those found at the National Bureau of Standards. Attempts were made to obtain a lacquer which is impermeable to moisture, but without success. To minimise the variations in resistance, the tubes on which some of the coils were wound were rendered elastic by providing them with three longitudinal slits, and this construction appears to be a distinct advance on the usual form. For great accuracy the author suggests that resistance boxes should be filled with insulating oil of a certain density. [See also Abstract No. 1564 (1907.)] F. E. S.

1679. *Construction of very High Resistances.* **H. L. Bronson.** (Amer. Electrochem. Soc., Trans. 13. pp. 231–239; Discussion, pp. 239–241, 1908.)—The problem presented to the author was to get an instantaneous measurement of very small currents, such as occur in radio-active measurements. Such a measurement involved the manufacture of permanent high resistances of the order of 10^{11} ohms. Carbon and liquid resistances were found to be unsatisfactory, and Rutherford suggested the use of an ionised gas. He had previously shown that the ionisation current, through a gas subject to a constant source of ionisation, is approximately proportional to the p.d. between the plates when this p.d. is small. The resistance used by the author is an ionised gas contained in an ebonite vessel with electrodes of aluminium. The active material consists of about 1/10 mgm. of radium bromide. In general the relation between the ionisation current in such a vessel and the p.d. between the plates is not linear, but depends upon the active material used, the kind and amount of insulation, and the distance between the plates. However, it is generally possible to adjust the latter so that a linear relation will exist for a considerable range of potential. F. E. S.

1680. *Temperature Formula for Weston Cell.* **F. A. Wolff.** (Amer. Electrochem. Soc., Trans. 13. pp. 187–208; Discussion, pp. 208–211, 1908.)—In this investigation 200 cells were studied, the measurements being made at every 5° for a complete cycle from 0° to 40°, beginning and ending at 25°. The temperature of the baths was maintained constant well within 0·02° C. for at least 40 hours at each temperature ascending and descending. Altogether 58 observations were made on each of the 200 cells, and 19 others kept at 25°, in completing the cycles. The relation between e.m.f. and temperature is best represented by the formula—

$$E_t = E_{20} - 0{\cdot}00004064\,(t-20) - 0{\cdot}000000948\,(t-20)^2 \\ + 0{\cdot}0000000096\,(t-20)^3.$$

This is in fairly good agreement with other formulæ for the Weston cell between 10° and 30° C., these temperatures being the useful limits for other formulæ. It appears that Weston cells can be set up which exhibit extremely little hysteresis in the range 0° to 40°, even when subjected to large and rapid temperature variations, and that no differences in temperature-coefficient arise from the methods of preparation of the mercurous sulphate used. The majority of cells in which hysteresis was found were set up with relatively coarse-grained white samples of mercurous sulphate. F. E. S.

1681. *Practical Standards for Electrical Measurements.* (Electrician, 61. pp. 844–847, Sept. 11, and pp. 876–879, Sept. 18, 1908. Abstract of Report of British Assoc. Committee. Elect. Engineering, 4. pp. 389–392; Discussion,

p. 892, Sept. 10, 1908.)—The results are given of the electrical measurements, of certain of the fundamental units, which have been in progress for some time at the National Physical Laboratory [see Abstracts Nos. 268, 469, 868, and 1150 (1908)]. An Appendix on the "Secular Changes of Standards of Resistance" is by **F. E. Smith.** It appears that mercury standards keep very constant in resistance, but that most of the original coils of the British Association have changed considerably. It is believed that the most constant coils are two of platinum, first measured in 1865. Results for the period 1903–8 are given for 22 manganin standards. Some of these have kept approximately constant, but others have changed considerably. In some cases it appears that some change must have taken place in the structure of the alloy. In a second Appendix specifications are given for the practical realisation of the definitions of the international ohm and international ampere, and instructions for the preparation of the Weston cadmium cell. F. E. S.

1682. *Cadmium Cells and Temperature.* **R. Jouaust.** (Comptes Rendus, 147. pp. 42–43, July 6, 1908.)—Cells with an amalgam containing 12·5 per cent. of cadmium obey Jäger and Lindeck's formula—

$$E_t = E_{20} - 0{\cdot}000038\,(t-20) - 0{\cdot}00000065\,(t-20)^2\,;$$

but if the cadmium be 10 per cent. the results are very irregular for temperatures below 10°. A. D.

1683. *Electrochemical Equivalent of Silver.* **F. Kohlrausch.** (Ann. d. Physik, 26. 3. pp. 580–596, July 7, 1908.)—Describes some experiments on various forms of silver voltameter. The object was to determine to what extent the anode liquid affected the result of F. and W. Kohlrausch in 1884. The syphon voltameter unexpectedly gave the heaviest deposit, but this result may be due to the fact that the syphon form was less protected from the light. None of the differences are so great as 1 part in 10,000, and all the larger voltameters were remarkably the same in their behaviour. The smaller ones gave on an average deposits greater than the mean by about 4 parts in 100,000. If the measurements of F. and W. Kohlrausch are to be corrected, the max. correction that should be applied is −2 parts in 100,000; that is, it is not necessary to modify the value 1·1183 mgm. on the score of influence of anode products. The author prefers the name "voltameter" to the name "coulometer" (coulombmeter) used by Richards. F. E. S.

1684. *Apparatus for determining the Form of a Wave of Magnetic Flux.* **M. G. Lloyd** and **J. V. S. Fisher.** (Bureau of Standards, Bull. 4. pp. 467–476, May, 1908.)—The apparatus depends for its operation on the fact that the value of the magnetic flux at any instant is proportional to the algebraic average of the induced e.m.f. during the succeeding half-period. A rotating commutator which reverses the contacts twice per cycle is the essential part, and four brushes, equally spaced, are mounted so that they can be set in any desired position. Two of the brushes are connected to a secondary coil which embraces the flux to be determined, and the other two are connected to a Weston voltmeter or some other instrument whose deflection is proportional to the first power of the current. The apparatus can also be used for plotting curves of e.m.f. and current. Examples of its use are given, and the degree of accuracy obtainable is discussed. T. F. W.

1685. *Moving-coil Galvanometer.* **W. Jaeger.** (Zeitschr. Instrumentenk. 28. pp. 206–210, July, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—Describes a sensitive moving-coil galvanometer of low resistance made by Siemens and Halske. It was constructed at the instigation of the Reichsanstalt. The instrument has a period of 5·5 sec. The resistance of the suspension wire and of the lower spiral are equal and amount together to about 9 ohms. The resistance of the coil is about 0·5 ohm. The sensitiveness is such that at a distance of 8 m. a 1-mm. deflection corresponds to about 1 × 10^{-7} volt. F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

1686. *Magnetic Susceptibility of Solutions.* **P. Pascal.** (Comptes Rendus, 147. pp. 242–244, July 27, 1908.)—When, in an aqueous solution, the metal ion of a salt passes without change of valency into a complex ion or colloidal compound, the magnetism or diamagnetism of the solution becomes less than that of the original solution. Inversion of the type of magnetism may even occur. Further, the same phenomenon is observed when the metal passes from a less to a more complex ion. This result is founded on observations upon salts of Fe, Co, Cr, Cu, and Hg. If it holds generally, then the magnetic test can be used as a delicate indicator of complex groups. The rate of oxidation of salts can be followed in this way. Thus with complex ferrous salts (pyrophosphate, oxalate, metaphosphate) the rates of oxidation, upon bubbling air through the solution, were in the inverse order of the magnetic susceptibilities, *i.e.*, of the complexities. F. R.

1687. *Earth Currents and Magnetic Variations.* **L. Steiner.** (Terrestrial Magnetism, 13. pp. 57–62, June, 1908.)—Discussion of the question whether magnetic variations are entirely or in part due to the electromagnetic action of earth currents, or whether the earth currents are induced by the magnetic variations. If the earth currents were the primary causes of the daily magnetic variations, we should expect that the W.–E. components of the currents are connected with the north components of the variations, as suggested by the Paris observations, and the N.–S. components of the currents with the W.–E. components. Investigations by Schuster, v. Bezold, and Fritsche have shown that the daily variations of terrestrial magnetism are to be ascribed to two causes, one outside, the other inside, the earth. After plotting the observations discussed it is suggested that the two components appear to be independent, and that there may be a difference between the N.–S. and E.–W. earth currents as regards their origin. C. P. B.

1688. *Magnetic Phenomena during Total Solar Eclipse.* **C. Chree.** (Terrestrial Magnetism, 13. pp. 73–78, June, 1908.)—Commenting on Nordmann's paper on magnetism during the solar eclipse of Aug. 30, 1905 [Abstract No. 1576 (1907)], the present author thinks another explanation may be found for the phenomena observed. The quantities employed by Nordmann are considered too small to be of practical value, and in some cases may be much beyond the possibility of actual observation. With regard to the method adopted for eliminating the disturbance element and the regular diurnal variation, it is necessary to point out that there is no *fixed* regular diurnal inequality characteristic of a month or portion of a month. Chree then takes other pairs of differences between the stations considered, and the curves obtained show little or no evidence of perturbation near the time of eclipse. **C. Nordmann.** (Ibid. pp. 76–78.)—In reply to the above criticism, Nordmann explains that the corrections for diurnal inequality were only taken from a set of quiet days, not from the disturbed days near the eclipse time. The dissimilarity of the curves depends to a considerable extent on the intensity of the solar radiation at the stations chosen. C. P. B.

1689. *Earth's Residual Magnetic Field.* **A. Tanakadate, L. A. Bauer.** (Terrestrial Magnetism, 13. pp. 67–71, June, 1908. Extract from Denkigakukwai Zassi, No. 220.)—Bauer has constructed a map of residual magnetic field after deducting the first harmonics in Gaussian expansion from the observed values of each component, and has determined in this way several centres of attractions and repulsions on the earth's surface. Tanakadate has had another map made from the differences in Schmidt's paper to see what will be the residual values after deducing all the harmonics from the observed values. Considering the improbability of our ever being able to accurately represent the earth's field by a definite formula, a proposal is made for a limitation of the number of terms to be used in the evaluation, and for the adoption of a *normal field of reference.* C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

1690. *Röntgen Tubes with Unidirectional Induced Currents.* **E. Ruhmer.** (Electrician, 61. pp. 643–645, Aug. 7, 1908. Lecture to the Deutsch. Röntgen-Gesell.)—The induced current at "make" is very deleterious to the life of Röntgen tubes. The author discusses the principal methods used to overcome this disadvantage; choking tube or spark-gap in series with the Röntgen tube; adjustment of relations so that the "make" induced current is not sufficient to break down the tube, by decreasing the ratio of transformation or else the primary voltage. A new arrangement is described whereby the "make" voltage is removed without interfering with that at "break," by means of a contact whereby the greater part of the induced current at "make" is taken from an auxiliary or protective winding on the primary core, and so passes away into the secondary winding. The efficient working of the protective winding is dependent on a slow rise of the electromagnetic field. A. D.

1691. *Measurement of the Current through a Röntgen-ray Tube.* **W. Duddell.** (Röntgen Soc., Journ. 4. pp. 100–110; Discussion, pp. 111–114, July, 1908.)—Measurements were made of the mean and the mean-square value of the current through a Röntgen tube with the view of investigating if there was some relationship between these two quantities which would be of assistance in making Röntgen-ray measurements. The wave-form of the current passing through the tube was first determined. A 12-in. induction coil with a Levy mercury turbine interrupter and a rectifying spark-gap was used. The instantaneous current was recorded by means of an oscillograph, and some typical records of wave-forms are given in the paper. The mean current was measured by means of a moving-coil galvanometer, and one of the author's sensitive pivoted thermo-ammeters was used for the measurement of the mean-square current. Preliminary experiments indicated that the current through the tube consisted of isolated pulses lasting a very short time during which the current rose and fell very rapidly. The main difference between the curves obtained when the vacuum was low and the vacuum medium is that with the low vacuum, the small oscillation in the negative direction following the main pulse of current through the tube is almost entirely absent. One striking result of the tests has been the demonstration how little the type of the wave-form is affected by the degree of vacuum of the Röntgen tube. For the same mean current, the higher the vacuum the greater was the max. value of the current, and the less the time it lasted. Observations were made on the p.d. and current wave-forms, and it was found that the type of the wave-form of the current and that of the p.d. between the terminals of the tube was very constant. It appears that the max. value of the current is from 1¼ to 2 times the mean-square current divided by the mean current. Thus it may be possible to determine the max. current by measurements of these last two values without the use of an oscillograph. J. J. S.

1692. *Kathodic Flame Rectifier used as Rheostat.* **T. Nogier.** (Archives d'Él. Médicale, 16. pp. 700–708, Sept. 10, 1908.)—Shows that Cathiard's flame rectifier [Abstract No. 475 (1908)], especially when the kathode is a cored in place of a solid carbon, serves as a very useful rheostat, the resistance being capable of being varied by simply altering the distance between the kathode and the burner. In this way, used with a Röntgen tube, the current through the tube was reduced from 2·2 milliamps to 1·2 milliamps without altering in any way the radiochromometric power of the rays. L. H. W.

REFERENCES.

1693. *Electromagnetic Theory.* **G. Jaumann.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 379–548, March and April, 1908.)—An attempt to formulate a theory which shall embrace the known phenomena of chemistry, magnetism, electricity, optics, radio-activity, and moving media in one comprehensive scheme. E. H. B.

1694. *Surfaces of Electromagnetic Variations and their Propagation.* **L. Silberstein.** (Ann. d. Physik, 26. 4. pp. 751–762, July 28, 1908.)—A mathematical paper which applies the methods of E. B. Christoffel, H. Hugoniot, and J. Hadamard, and thus obtains the well-known results of Maxwell that the electric and magnetic vectors e and m are perpendicular to each other and to their direction of propagation, the two vectors being connected by the relation $Ke^2 = \mu m^2$. E. H. B.

1695. *The Striated Positive Column in the Glow Discharge.* **R. Holm.** (Phys. Zeitschr. 9. pp. 558–562, Sept. 1, 1908.)—Measurements were made of the fall of potential and the distance between the striæ in the positive column, and the connection between these quantities and the current strength and gas pressure was investigated. The results are recorded in the form of diagrams. The methods used for measuring the fall of potential were those of Stark and H. A. Wilson, and the gases employed were hydrogen, nitrogen, and helium. J. J. S.

1696. *Feebly Damped Oscillations for Laboratory Measurements.* **L. W. Austin.** (Bureau of Standards, Bull. 5. pp. 149–152, Aug., 1908.)—Constructional details of an arrangement for producing weak oscillations of definite wave-length.

1697. *Radiation from an Elliptically Vibrating Oscillator in Free Space.* **K. Uller.** (Jahrbuch d. Drahtlosen Telegraphie, 1. 4. pp. 570–584, Sept., 1908. Extract from Habilitationsschrift, Giessen.)—A mathematical consideration.

1698. *Damping Phenomena with Electric Oscillations.* **M. Grober.** (Jahrbuch d. Drahtlosen Telegraphie, 1. 3. pp. 359–369, May, and 1. 4. pp. 488–496, Sept., 1908.) —The treatment is mainly mathematical and does not lend itself to abstracting.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1699. *Theory of Dulong and Petit's Law.* **F. Richarz.** (Zeitschr. Anorg. Chem. 58. 3. pp. 356–374, June 13, and 59. 1. pp. 146–160, July 8, 1908. Physikal. Inst. d. Univ., Marburg.)—The author gives a *résumé* of the work published by him since 1893 on the theory of Dulong and Petit's law. On certain assumptions, it is shown that the atomic heat of solid elements at constant volume has the constant value 6·012. At constant pressure the atomic heat is greater than the above value, owing to the attraction of the atoms having to be overcome, the values varying from 6·072 to 6·914 for different elements. The theory requires variations of the atomic heat, and explains the abnormally low values given by some elements. The law only holds exactly for a few "ideal" solid elements. That the atomic heats of gases at constant volume should have the constant value, 3, admits of simple proof. T. H. P.

1700. *Foam-structure of Sulphur and its Influence on Double Refraction, Dichroism, Electrical Properties and Formation of Crystals.* **G. Quincke.** (Ann. d. Physik, 26. 4. pp. 625–711, July 28, 1908.)—A *résumé* of the literature is first given, after which the author's experiments are described and the following conclusions drawn: The brown, ropy liquid formed by molten sulphur between 160° and 260° is a liquid jelly with visible and invisible foam-walls. The surface tension of molten sulphur is: at 120–160°, 6–5·5 mgm. per mm.; at 250°, 12, and at 448°, 4·5 mgm. per mm. With sulphur rapidly cooled and just on the point of solidifying, the surface tension is 17 mgm. per mm. Sulphur exists in four allotropic modifications, S_γ, S_δ, S_β, and S , which are stable at about 448–300°, 300–160°, 160–96°, and 96–0° respectively. Mobile yellow sulphur spreads out on mercury to a thin skin with folds and invisible foam-walls, or forms a thin, flat drop, the shining underneath side of which discharges an electroscope. Viscous, brown sulphur does not spread on mercury, but solidifies to a thick, flat drop, the lower side of which is insulating. Molten sulphur and also supercooled sulphur may consist of several mixtures or solutions A, B, C . . . . of S_γ, S_δ, S_β, and S_α, which are oily liquids with surface tensions at their limiting surfaces. The higher the temperature to which molten sulphur is heated, and the more rapidly it is cooled, the greater the content of S_γ in the supercooled liquid. The modifications of sulphur stable at higher temperatures change gradually into those stable at lower temperatures and finally into S_α. For the remaining conclusions and the experimental data the original must be consulted. T. H. P.

1701. *Effect of Kathode Rays on Colours of Certain Minerals.* **C. C. Hutchins.** (Phys. Rev. 27. pp. 87–89, Aug., 1908.)—By the action of kathode rays, colourless or green fluorite is transformed into the amethyst variety, the change being only superficial with a low vacuum or strong current, but penetrating deeply into the mineral with a high vacuum or a weak current. Pink tourmaline is changed to green, and corundum, having a light purple tint, becomes paler under the influence of the rays. Green apatite fluoresces green, flesh-coloured apatite and blue cyanite red, and a perfectly transparent, nearly colourless piece of cyanite, a brilliant yellow. The occurrence of alternate bands of colourless and amethyst fluorite, and the bi-colouration of tourmaline may be in some way connected with the pyroelectric properties of the minerals. W. H. St.

1702. *Distillation of Turpentine by Electricity.* **F. T. Snyder.** (Amer. Electrochem. Soc., Trans. 13. pp. 371–376, 1908.)—The author describes plant for distilling turpentine from pine wood, the heating being effected electrically, which admits of close regulation of the temperature. The wood is placed in cans, which are introduced into brickwork retorts heated by a current passing through wrought-iron strips threaded through the brickwork at each side of the retort. Details of the operations are given. T. H. P.

1703. *Ozonisation of Air by Radium Salts or their Emanation.* **R. Nasini** and **M. G. Levi.** (Accad. Lincei, Atti, 17. pp. 46–49, July 19, 1908.)—By placing an open bottle, containing 5 mgm. of radium bromide, dissolved in 80 c.cm. of water, in a 5-litre vessel filled with air, closing the latter with a ground-glass stopper, and leaving for some hours at the ordinary atmospheric temperature, the air acquires a distinct odour of ozone, and gives the characteristic ozone reaction with potassium iodide and starch. When the ground-glass stopper is replaced by cork or indiarubber, no ozone can be detected. Air charged with the emanation from radium bromide, and aspirated from one large vessel to another through a warm tube, failed to show any formation of ozone. W. H. St.

1704. *Formation of Mists in Presence of Radium Emanation.* **Mme. Curie.** (Comptes Rendus, 147. pp. 379–382, Aug. 17, 1908. Chem. News, 98. pp. 156–157, Sept. 25, 1908.)—The author has previously shown [Abstract No. 1829 (1907) and Comptes Rendus, 145. p. 1145, 1907] that the presence of radium emanation effects the condensation of saturated and unsaturated water vapour and other vapours in the form of a persistent mist visible in the light of an electric arc. The centres of condensation are neither the ions formed in the gas nor the molecules of emanation, but may be regarded as particles of induced radioactivity suspended in the gas and acting either by the electrostatic action of their charge or by chemical affinity. With pure water and air charged with emanation, a feeble mist, lasting for some days, is observed. When the air is replaced by CO_2, persistent mist is not formed with pure water but only with a mixture of water and sulphuric acid or with the latter in a concentrated state. In these cases the condensation nuclei cannot be particles of induced radio-activity, since these particles exist in the CO_2 as well as in the air. When air and water are used the centres of condensation are possibly the nitrogen compounds formed in the air by the emanation, and when sulphuric acid is employed it would seem that particles of sulphuric anhydride exist in the gas in consequence of the action of the emanation on the liquid. Persistent, thick mists are also obtained with iodine in CO_2 charged with emanation and with camphor in air charged with emanation. But with iodine in air charged with emanation, the mist only lasts a few days. Actinium in presence of water and CO_2 also forms a mist. In an electric field the drops composing these mists behave as if they carried no charge. On examining the flasks in which the mists are formed, it is found that part of the CO_2 is converted into CO, that nitrogen compounds are formed when air is employed, and that traces of sulphuric and sulphurous acids are produced in presence of sulphur and air. T. H. P.

1705. *Action of Radium Emanation on Solutions of Salts of Copper.* **Mme. Curie** and **Mlle. Gleditsch.** (Comptes Rendus, 147. pp. 845–849, Aug. 10, 1908. Chem. News, 98. pp. 157–158, Sept. 25, 1908. Electrician, 61. p. 764, Aug. 28, 1908. Abstract.)—The authors have repeated the experiments of Ramsay and Cameron [Abstract No. 140 (1908)], in which traces of lithium were observed in the residues obtained from solutions of copper salts which had been submitted to the action of radium emanation. In these experiments, however, the use of glass vessels was carefully avoided, and quartz also was not used, as both these materials contain lithium. Platinum vessels were employed throughout, and the water and acids used (which contained traces of lithium) were purified by redistillation in Pt vessels and were then kept in Pt bottles. In order to purify the sulphate of copper used it was repeatedly crystallised from a solution n pure water, but it was very difficult to get rid of all traces of Li. In two experiments 7 c.cm. of solution of pure copper sulphate were treated with the emanation, the masses of metallic Cu employed being 0·26 and 0·14 gm. After removal of the Cu and the sulphuric acid the liquid when heated to dryness on Pt gave residues of 0·0004 and 0·0005 gm. in the two cases. Spectroscopic examination of the residue showed that it contained chiefly sodium and a little potassium; the presence of lithium was not detected. It was found possible, though with difficulty, to prove the presence of the red ray of lithium in a mixture containing 10,000 parts of Na_2SO_4 for one part of Li_2SO_4; so that the quantity of metallic lithium which could have been present was less than $0·6 \times 10^{-5}$ mgm. The authors consider that the fact of the formation of the elements sodium and lithium cannot be regarded as established. J. J. S.

1706. *Experiments at High Temperatures and Pressures. Application to Carbon.* **R. Threlfall.** (Chem. Soc., Journ. 93. pp. 1333–1356, July, 1908.) —The pressure vessel consists of two equal cylinders of steel placed end to end and insulated from one another by a sheet of mica. A plug of Acheson graphite forms the lower connection, and a magnesia lining is made by pressing in fused and ground magnesia in layers giving about 8 mm. additional thickness at each pressing under about 50 tons per sq. in. A small central hole is drilled in this compressed block *in situ*, and this and the narrower neck of the pressure chamber are filled with loosely pressed graphite. A plunger is then forced down the neck and a current passed through the graphite for a few sec. The magnesia lining to within 8 mm. of the steel walls is thus converted into a tube of fused magnesia. Upon cooling, the graphite can be scraped out and the mixture upon which it is desired to experiment put in its place, together with a suitable resistor if necessary. The design depends on the use of a considerable quantity of graphite as a means of transmitting pressure from a comparatively cool region, where the cross-section of graphite is large, to a hot one, where the cross-section is small. Preliminary trials showed that the pressure necessary to cause the graphite to flow was practically negligible. The advantage of dividing the pressure-vessel into two lengths with insulation between them is that short-circuits due to the penetration of the magnesia by filaments of graphite are obviated. Other linings are described. So far as the experiments on carbon covered the same ground as those of Parsons [see Abstract No. 1862 (1907)] the results obtained are in full agreement. Typical detailed data are given. The formation of diamond is discussed. The author's view is that the necessary conditions are a mixture from which a pure carbon phase can separate at a temperature which is not high enough, taking the pressure into consideration, for the rate of transformation to graphite to have an appreciable value. This temperature-range is probably very narrow; hence it seldom occurs in nature that diamond is formed rather than graphite. F. R.

1707. *Coating Metals.* **F. Mylius** and **F. F. v. Liechtenstein.** (Zeitschr Instrumentenk., Beib. 14. pp. 133–136, July 15, and 15. pp. 142–146, Aug. 1, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—An apparatus is described for testing coatings on metals—*e.g.*, plating, chemical colour deposit, lacquer, &c. The sample is in the form of a cylindrical bar, 2 cm. diam., and rotates at a uniform speed. A linen band under constant tension is in contact with the bar after the manner of a band brake. The time taken for the band to wear through the coating is observed. Deposits of As or Sb wear up to 2 min., according to thickness of deposit; lacquer from 1 to 4 min.; copper oxide on brass, formed by the wet method, 2 min.; copper oxide, formed by heating, 3 min. The wet method of colouring brass with copper oxide is studied in detail. The solution used consists of salammoniac and copper carbonate. The effect of the variables (temperature, concentration, relative concentration in copper and ammonia) is well marked in affecting the quality of deposit, which may be black (cupric oxide), yellow (cuprous oxide), red (copper), blue (copper hydrate), or white (zinc oxide). Detailed chemical tests of the perfection of continuity and uniformity of the deposit are given. F. R.

1708. *Rare Metals.* Part II. *Tungsten.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 13. pp. 481–541, 1908. Translation.) This memoir contains a detailed account of tungsten, including sections on the following subjects: History, technical compounds, tungsten minerals and their distribution, mechanical preparation of ores, manufacture of tungstic acid, cast tungsten, metallic tungsten, nickel-tungsten chrome-tungsten and ferro-tungsten; the influence of the metal on steel and methods of chemical analysis of tungsten minerals and steels. Pure tungsten, according to recent figures, has a melting-point of 2,800° to 3,000°; when pure and porous it can be welded by forging at about 1,000°, can be drilled and filed easily and is not magnetic. The density varies according to the method of preparation, pulverulent varieties varying from 17 to 18, melted W 18·7, and when heated to 1,000° and subjected to a pressure of 200 atmos., 18·92. Its sp. heat is about 0·034, and increases with the temperature. Its electrical resistivity is 86×10^{-6} ohm per cm.^{3} at 20°. W is attacked by F at ordinary temperatures, by Cl at 300°, by Br at low redness, and by I only at a bright cherry-red heat. Oxygen, either dry or moist, has only a feeble action on it at ordinary temperatures, but the metal blackens little by little in the air; at redness the metal is attacked by oxygen, tungstic acid being formed. Tungsten is not sensibly attacked by water at ordinary temperatures, but is rapidly attacked by water vapour at redness. The following compounds of W have been isolated and studied: WB_2, W_2C, WC, W_2Si_3, W_3Si (doubtful), W_2Al, WAl_3, WAl_4, WNi_2, W_2Ni_3, W_2Fe, W_2Fe_3, WFe_2, WFe_3, WMn, WMo, W_2Mo_3, WPb and WPb_2. With regard to impurities in commercial W, up to 3 per cent. carbon is allowable for making low W-steels, but for special tool steels the carbon should be lower. In making W-steels, the introduction of W in the form of carbide is found to give different properties to a metal of similar composition; it seems that to obtain uniform results, it is necessary to add the metal in a pure form or as ferro-tungsten. Carbon must be absent for the alloys of Cu-W and Al-W, and pure

W is also required for the manufacture of platinoid and partinium. Tungsten to be used in steel manufacture must not contain more than 0·05 per cent. P or 0·1 per cent. S. For high-speed tool steels, more than 0·5 per cent. Mn and 0·2 per cent. Si is not permitted. The effect of W on steel is to greatly increase its hardness and to give it a fine grain and velvety appearance. Quenching gives to a W-steel a very close grain and silky appearance on fracture; quenching lowers the tensile strength of these steels, but this property is regained by heating to a high temperature. Tungsten lowers the melting-point of steel, this lowering being, according to Raoult's law, inversely proportional to the molecular content, but is only produced up to a certain addition of W, after which the melting-point is increased. Non-carburised W raises the points of transformation; carburised W, added to high-carbon steels, lowers them a little. The critical points are notably displaced, depending on the temperature at the start and the rate of cooling. The microstructure of W-steels consists of pearlite in 0·2-C steels containing 0 to 10 per cent. W, and in 0·8-C steels from 0 to 5 per cent. W; as soon as these amounts of W are exceeded, the double carbide appears in white filaments or grains. [For Part I. Molybdenum, see Abstract No. 1180 (1908).]

C. O. B.

1709. *Physico-chemical Studies of Explosive Platinum Metals.* **E. Cohen** and **T. Strengers.** (Zeitschr. Phys. Chem. 61. 6. pp. 698–752, Feb. 25, 1908.)—Explosive platinum metals are prepared by melting together with Zn, and dissolving out the latter metal by means of acids; in this way explosive forms of Rh, Ir, and Ru are obtained; Pt behaves irregularly, and Pd and Os do not give explosive modifications at all. The explosive properties of the rhodium can be removed by prolonged heating at 100 to 200°; at higher temperatures the heating causes an explosion. The explosive Rh contains Zn which cannot be removed by acids, and also hydrogen and oxygen; exclusion of air during the preparation eliminates the explosive properties of Rh and of Ir, but not those of Ru. The heat liberated during the explosion is of the same order as that which would be liberated by the combination of the hydrogen and oxygen contained in the metal, and there is little doubt that the peculiar behaviour of the metal is due to the explosion of the occluded gases and not to any allotropy of the metal.

T. M. L.

1710. *Pyrophoric Alloys.* **B. Weiss.** (Zeitschr. Elektrochem. 14. pp. 549–551; Discussion, p. 551, Aug. 28, 1908. Paper read before the 15 Hauptversamml. d. Deutsch. Bunsen-Gesell.)—In the electrolytic deposition of cerium on iron wire, the middle layers are found to be remarkably pyrophoric; the outside layers, being free from iron, are not pyrophoric. Cerium obtained by electrolysis with carbon poles is not pyrophoric. The alloy with 30 per cent. Fe, shows the pyrophoric effect at a maximum, and when touched with a file this alloy gives brilliant sparks. For stronger alloys the Fe may be increased; even up to 75 per cent. Fe, the phenomenon is observable. It appears that the two metals can be alloyed in all proportions. While pure Ce-metals are soft and oxidisable in the air, these alloys are hard, non-oxidisable at ordinary temperatures, and brittle. The melting-point is near that of cast iron. The Fe may be replaced, either entirely or in part by Ni, Co, and Mn. If the Fe be entirely replaced by these metals the pyrophoric effect is very marked. Silicon reduces the effect. The alloys are made by the addition of very finely divided Fe to very fluid Ce metal, and must be cast out of contact with air. Although Ce and La are very similar in effect there are certain differences, Ce most readily giving the sparks whilst La gives the most intense light. The paper suggests technical applications for these alloys such as for the automatic lighting of gas lamps and miner's lamps, and also for lighthouses and signalling purposes. C. O. B.

1711. *Preparation of Calcium Alloys for Aluminothermic Work.* **O. P. Watts and J. M. Breckenridge.** (Amer. Electrochem. Soc., Trans. 13, pp. 153–161; Discussion, pp. 161–168, 1908.)—After surveying the work done by others with regard to the reduction of metallic oxides and other compounds by means of Al, Ca and Si, the authors give an account of their own experments in this direction. Alloys containing varying percentages of Al, Ca, Mg and Si were prepared, and attempts were made to reduce MoO_2, MoS_2, WO_3, SiO_2, Fe_2O_3, Mn_3O_4, TiO_2, and mixtures of these with the following results: Alloys of Ca with Al and Mg can be easily prepared up to Ca contents of 70 per cent. Alloys containing 25 per cent. or more of Ca or Mg can be easily pulverised. In the absence of any considerable amount of Si, alloys containing much Ca or Mg react very violently in the reduction of oxides, and the yield of metal is small. So far as tested, the addition of Si to alloys of Al and Ca in the proportion necessary for the formation of $CaSi_2$, renders the reaction quiet and increases the yield of metal. Metallic Mo, Ti, with a small percentage of Al, but no W were obtained. Some of the experiments were carried on under pressure and some in a vacuum. O. J. S.

1712. *Alloying of Calcium and Iron.* **A. Hirsch and J. Aston.** (Amer. Electrochem. Soc., Trans. 13. pp. 143–150; Discussion, pp. 150–151, 1908.)—By reducing the oxides of cerium and iron with metallic calcium, masses containing all three metals or in some cases only Ca and Fe, were obtained. Negative results were found upon heating (1) a mixture of calcium-copper alloy with electrolytic iron, (2) mixture of Fe_2O_3 and calcium carbide, (3) electrolytic iron and Ca. Upon plunging a piece of Ca under the surface of molten Fe the product again contained no Ca. All of these failures are attributable to volatilisation of Ca, which was found to occur at 1,290°–1,300° C. From 0·14 to 6·75 per cent. Ca was apparently caused to alloy with Fe, by first enclosing the Ca in an iron tube, thrusting this beneath the surface of the molten iron, and removing the source of heat. Alloys containing from 0·29 to 1·87 per cent. Ca were produced by the reduction of Fe_3O_4 by metallic Ca under pressure. With more than 0·5 per cent. Ca the alloys will decompose hot water, and the 1·87 per cent. alloy decomposed cold water with evolution of gas from which acetylene was absent. Alloys containing above 4 per cent. Ca oxidise readily in the air. The presence of a small amount of Ca in iron destroys the power of welding. There is very little likelihood of finding Ca in iron made by the ordinary metallurgical processes. F. R.

1713. *Binary and Ternary Alloys of Copper, Zinc, and Nickel.* **V. E. Tafel.** (Metallurgie, 5. pp. 343–352, June 22; 375–388, July 8, and pp. 413–430, July 22, 1908. Communication from the Metallograph. u. Metallurg. Laborat. d. Königl. Bergakademie, Freiberg.)—*System: Copper-Nickel.*—The results are in entire agreement with those of Guertler and Tammann [see Abstract No. 344 (1907)]. The properties dealt with are the curves of solidification and the microstructure. *System: Copper-Zinc.*—The authors' results are almost entirely in agreement with those of Shepherd [see Abstract No. 2774 (1904)].

Roberts-Austen's line dd' does not exist. The compound Cu_2Zn_3 (melting-point about 880°) exists, and the existence of Cu_4Zn is possible, but there are no other compounds. Shepherd's lines e_3e_4 and Cc_1 were not found, and the horizontal GF of both Shepherd and Roberts-Austen was found to fall about 6° or 7° with increasing Zn. These alloys show a tendency to segregation when the concentration is in the neighbourhood of 50 per cent. Zn. *System : Zinc-Nickel.*—The author's experiments covered the range 0 to 50 per cent. Ni, and whilst generally confirming recently published results, can be summarised as follows. There occur seven different constituents in this range, viz., pure Zn, mixed crystals from 12·2 to 28 per cent. Ni, the compound $NiZn_3$ (melting-point 876°), mixed crystals containing from 39·7 to 49 per cent. Ni, and three other constituents whose exact nature is not yet determined. *System : Zinc-Copper-Nickel.*—No triple compound nor triple eutectic was found. The solidification surface in the temperature-concentration diagram of the ternary series falls at first slowly from the Cu-Ni side, then more rapidly as the Zn corner is approached. It consists of three surfaces corresponding to the formation of primary mixed crystals. Of these, that which corresponds to the alloys richest in Zn meets the next in a eutectic curve. The system Cu_2Zn_3–$NiZn_3$ forms mixed crystals, the series being represented by an almost straight line. The technically important alloys of this series consist, with few exceptions, of mixed crystals which have not undergone any change since solidification. Alloys with about 15·8 to 20 per cent. Ni, 73 to 80 per cent. Cu, and 7 per cent. Zn resemble silver in both colour and ductility. Alloys with 38 to 40 per cent. Ni, 7 to 40 per cent. Cu and 40 to 52 per cent. Zn have great hardness and strength. F. R.

1714. *Electrolytic Corrosion of Brasses.* **A. T. Lincoln** and **G. C. Bartells, Jr.** (Amer. Electrochem. Soc., Trans. 13. pp. 331–336; Discussion, p. 337, 1908.)—Copper-zinc alloys which had been annealed at 400° C. for several weeks were corroded in solutions of sodium chloride, of West India bath salt, and in artificial sea-water, for from 6 to 7 hours, the brasses being the anodes, and rotating, and the current used 0·08 amp. The losses of brass by corrosion, and the proportion of this which is copper, are recorded. The curves relating these data with the composition of the alloys are of similar type for all of these solutions. The rate of corrosion is greater the higher the copper content. With less than about 58 per cent. Zn the Cu in the alloy remains practically unattacked, and the current efficiency is then low. In the *discussion*, **J. W. Richards** pointed out the inapplicability of the results to sea-water, as the experiments were made in small vessels with a confined sample of electrolyte, whose composition therefore was continuously varying. F. R.

1715. *Iron-Silicon-Carbon Alloys.* **W. Gontermann.** (Zeitschr. Anorg. Chem. 59. 4. pp. 373–413, Sept. 7, 1908. Metallographic Communication from the Inst. f. physikal. Chemie d. Univ., Göttingen.)—Contains results of a thermal and metallographic research on some of the above alloys, giving equilibrium diagrams for Fe-C and Fe-Si systems and also for the ternary system Fe-Si-C. Discusses the probability of the formation of two immiscible liquids in the Fe-C system for alloys containing over 4·5 per cent. C, at temperatures above 1,200° during cooling, and gives a suggested modification of the equilibrium diagram. The following changes take place during the cooling of the solid alloys : Silicon-α-ferrite or silicon-β-ferrite separates from silicon-martensite, silicon-cementite crystallises from silicon-martensite. Pearlite formation takes place at 760° in alloys containing from 3–4 per cent. Si. In the alloy containing 9·6 Si, 1·22 C, the cooling-curve gave no indication of pearlite formation. A few typical photomicrographs are given to illustrate structures. C. O. B.

1716. *Heat Treatment of Muntz Metal.* II. **G. D. Bengough** and **O. F. Hudson.** (Soc. Chem. Ind., Journ. 27. pp. 654–658; Discussion, p. 658, July 15, 1908. Paper read before the Birmingham and Nottingham Sections.) —It is found that the shock test (Izod machine) does not give results which are sufficiently discriminative to be useful with Muntz metal variously heat-treated. There is a tendency for the shock-test figures to follow elongation in cold-rolled bars, and max. stress in hot-rolled bars. The relative proportion of the constituents α and β remained constant in a particular bar, with a variety of annealing temperatures above 550° at about 67 per cent. α : 33 per cent. β, but was affected by rate of cooling. Duration and temperature of annealing affect type and coarseness of structure only. The rolled structure is the type of greatest strength, while the "island" type (islands of β) has greatest ductility; the network type has moderate strength and ductility, the cast type is weakest. The conclusions are summarised in the following table :—

Approximate Annealing Temperature Limits, Deg. C.	Max. Stress, Tons per Sq. In.	Elongation per Cent. on 2 in.	Type of Structure.
0–500	31–27·5	Cold rolled 37–50	Rolled
		Hot „ 47–65	
500–575	Cold rolled 26–24	Cold rolled 52–60	Island
	Hot „ 26–21	Hot „ 55–65	
575–790	Cold rolled 23·5–22·5	Cold rolled 50–57	Network
	Hot „ —	Hot „ 65–72	
790–895	Cold rolled 23·5–22·5	Cold rolled 17–44	Cast
	Hot „ 21–20	Hot „ ? 72	

[See also Abstract No. 495 (1908).] F. R.

1717. *Iron-Carbon Alloys.* **H. le Chatelier.** (Soc. d'Encouragement, Rev. de Métallurgie, 5. pp. 167–172, March, 1908. Stahl u. Eisen, 28. pp. 1113–1115, July 29, 1908.)—Outlines the present knowledge of the constitution of iron-carbon alloys. At the present time, the principal questions to be settled are: (1) the exact nature of the constituent or constituents variously called troostite, troosto-sorbite, osmondite, and sorbite; (2) as to whether β-iron plays any part in the solid solution which constitutes fully hardened steel; (3) as to why the electrical resistance of martensite increases with increased quenching temperature. F. R.

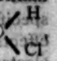
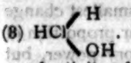
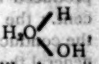
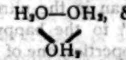
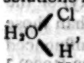
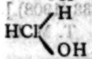
1718. *Refining Steel by Sodium.* **A. Hiorth.** (Iron and Steel Inst., Journ. 77. pp. 258–264, 1908.)—It is concluded that iron treated with small quantities of Na is more fusible, and more free from oxygen than if not so treated. Sodium peroxide can be obtained by treating iron, or iron ore containing oxygen, with sodium. **A. E. Tucker.** (Ibid. pp. 264–266.)—Tucker adversely criticises the conclusions. F. R.

1719. *Electrical Properties of Dilute Solutions of Sulphuric Acid.* **W. C. D. Whetham and H. H. Paine.** (Roy. Soc., Proc. Ser. A. 81. pp. 58–80, July 30, 1908.)—A continuation of previous work [see Abstract No. 416 (1906)]. Using a special cell, the migration constant or transport ratio was determined for solutions of sulphuric acid of concentration varying from 0·1 to 0·00001 normal. A current was passed through the migration cell, and the total change in the quantity of solute round the anode and kathode measured. The value of the change at either electrode in gm.-equivalents, divided by the number of gm.-equivalents of hydrogen evolved at the kathode, gives the migration constant for the solution. The experiments seem to show an increase in the migration constant at extreme dilutions. It is sought to explain the effect by the association of ions brought together in solution. Such an association would take place if the solvent contained: (1) a weak acid such as carbonic acid, (2) a weak alkali such as ammonia, or (3) a salt formed by the neutralisation of a weak acid by a weak alkali, such as ammonium carbonate. To complete the solution of the problem, it would be necessary, either to obtain an exact knowledge of the impurities of water, so as to allow for their effect, or to use water which contained no such impurities. G. E. A.

1720. *Vapour Pressure and Osmotic Pressure of Strong Solutions.* **H. L. Callendar.** (Roy. Soc., Proc. Ser. A. 80. pp. 466–500, June 10, 1908. Zeitschr. Phys. Chem. 63. 6. pp. 641–682, Aug. 21, 1908.)—The author deduces formulæ for the variation of concentration of a solution in a vertical column, and for the variation of osmotic pressure with hydrostatic pressure. In the case of the sugar solutions studied by Berkeley and Hartley, it is shown that the variation in concentration is considerable, amounting, in the case of the strongest solutions, to as much as 18 per cent. The author also discusses the theories of osmotic pressure which have been put forward, and concludes from a comparison of experimental data with his equations that there are definite hydrates formed in solution. He also indicates how the degree of hydration can be determined, and finds in the case of cane-sugar a value of 5 for the degree of hydration. A. F.

1721. *Physical Modifications of Gelatine in Presence of Electrolytes and Non-electrolytes.* **J. Larguier des Bancels.** (Comptes Rendus, 146, pp. 290–291, Feb. 10, 1908.)—In presence of various neutral salts gelatine dissolves in water at the ordinary temperature, salts of bivalent metals exercising a more energetic solvent action than those of monovalent metals and nitrates having a greater effect than chlorides. In presence of electrolytes, gelatine dissolves in mixtures of non-electrolytes—for example, alcohol or acetone with water—these mixtures being more favourable to solution than water alone; the presence of a small quantity of water is necessary for any solution to take place, but when this amount has been reached the solution of the gelatine is accelerated by increasing the proportion of the non-electrolyte in the mixture. Gelatine dissolved in water or in mixtures of the latter with non-electrolytes can be recovered by removing the added salts either by dialysis or by a series of precipitations by excess of alcohol or acetone, the gelatine being obtained in its original condition. T. H. P.

1722. *Studies of the Processes Operative in Solutions.* VI. *Hydrolysis, Hydrolation, and Hydronation.* **H. E. Armstrong.** VII. *Relative Efficiencies of Acids deduced from Conductivities and Hydrolytic Activities.* **H. E. Arm-**

strong and **E. Wheeler.** VIII. *Influence of Salts on Hydrolysis.* **H. E. Armstrong** and **D. Crothers.** IX. *Determination of Optical Rotatory Power.* **R. J. Caldwell** and **R. Whymper.** X. *Changes effected by Cane-sugar and other Substances in Aqueous Solutions.* **R. J. Caldwell** and **R. Whymper.** (Roy. Soc., Proc. Ser. A. 81. pp. 80–140, Aug. 11, 1908.)—VI. It is suggested that an aqueous electrolyte, such as HCl, may contain isomeric hydrates of different types, such as (1) $H_2O:ClH$, (2)  $H_2O\langle^{H}_{Cl}$, (3)  $HCl\langle^{H}_{OH}$. The first is regarded as being an inactive complex, the conductivity of the solution and most of its chemical reactions being attributed to the second and third types, in which either the HCl or the water is resolved into two radicals, although (in opposition to the theory of electrolytic dissociation) these are regarded as attached to a common molecule and not set free. Water itself is also regarded as containing active molecules such as "hydrone" OH_2 and "hydrone-hydrol" (briefly hydronol)  $H_2O\langle^{H}_{OH}$, together with inactive molecules containing closed rings such as "dihydrone" $H_2O:OH_2$, "trihydrone"  $H_2O\text{—}OH_2$ (with OH_2 below, joined to both), &c. Conductivity in concentrated solutions is attributed mainly to "hydrolysed" solute molecules of the type  $H_2O\langle^{Cl}_{H}$, whilst in weak solutions "hydrolated" molecules of the type  $HCl\langle^{H}_{OH}$ are mainly responsible for the conduction; this interpretation has the advantage of recognising the essential unity of behaviour of the closely allied elements oxygen and chlorine (compare B.A. Report, Leeds, 1890, p. 326). Other questions discussed from the same point of view are hydrolysis, interaction of acids and alkalies, hydration, ionic properties, electrolytes and non-electrolytes, optical and other properties of solutions; in regard to these reference should be made to the original paper. VII. The velocities of inversion of cane-sugar by HNO_3, HCl, and H_2SO_4, each diluted with 55·5 H_2O (1 gm.-mol. to 1,000 gm. water) are in the ratio 468 : 499 : 552. Equal velocities are attained when the acid-concentrations are $HNO_3 + 55·5H_2O$, $HCl + 58·5H_2O$, $H_2SO_4 + 62·5H_2O$; the additional molecules of water required to produce equality are regarded as due to the greater hydration of the two latter acids. The curves showing the effect on conductivity and on hydrolytic activity of changes in the concentration of the acid are of different forms, although the acids fall into the same relative positions in the two series of curves; as *molecular* proportions were used the dibasic sulphuric acid is assigned the highest conductivity and the greatest hydrolysing power, but the relative positions would be reversed if *equivalents* had been used; hydrochloric and nitric acids give curves which lie very close together. The most noteworthy result is that whilst dilution increases the molecular conductivity, it decreases the molecular hydrolytic activity of the acid, these changes being prolonged to greater dilutions in the case of the dibasic than of the monobasic acids. VIII. A discussion of the conditions which determine the hydrolysis of methyl acetate by acids in presence of their salts. IX. The authors describe certain improvements in the measurement of optical rotation, some of which are novel. X. The changes of rotatory power produced by the addition of salts to cane-sugar solutions cannot be attributed to a "concentration effect" (removal of the solvent in the form of hydrates by the salt), since the alterations produced cannot be cancelled by dilution except by adding a quantity of water altogether out of proportion to that which it is reasonable to suppose could be withdrawn by the salt. In the case of cane-sugar itself, dilution produces only a very slight increase of specific rotatory power, but this is attributed to the balancing of opposite effects produced by depolymerisation and by hydration. Of nine non-electrolytes examined, seven were found to produce only the smallest change of specific rotatory power (less than 0·2 per cent.); a molecular proportion of aldehyde produced a rise of about 1 per cent. in the rotatory power, but chloral hydrate produced a decrease of rather smaller magnitude. Alkalies produce a marked increase of rotatory power (about 10 per cent. for molecular proportions); their conductivity is, however, decreased to about one-quarter, and there is no doubt that in this case compounds are formed. The changes produced by salts are much smaller in magnitude, rarely exceeding 3 per cent.; the action of the sugar on the salt is, however, very conspicuous, as the conductivity is decreased by amounts varying from 48 to 51 per cent. In general the increase of rotatory power and the decrease of conductivity in the case of the chlorides are greater than in the nitrates, but less than in the sulphates. Attention may be called to the happy inspiration of studying mixed solutions by means of two properties, one of which (rotatory power) is characteristic only of the non-electrolyte and the other (conductivity) of the electrolyte; such investigations are likely to prove far more fertile than those in which the property measured (*e.g.*, density or refractive index) is influenced directly by all the constituents of the mixture. [See Abstract No. 333 (1908).]

T. M. L.

1723. *Conductivity and Viscosity of Solutions of Salts in Water, Methyl Alcohol, Ethyl Alcohol, and Acetone.* [*Mixed Solvents,* VII.] **H. C. Jones** and **W. R. Veazey.** (Zeitschr. Phys. Chem. 61. 6. pp. 641–697, Feb. 25, 1908. From the English.)—The salts investigated were copper chloride and potassium sulphocyanide, the behaviour of potassium iodide, lithium nitrate, calcium nitrate, silver nitrate, lithium bromide, and cobalt chloride having been described in previous communications. The most interesting points previously recorded were the occurrence of maxima of conductivity in solutions of several of the above salts in alcohol-acetone mixtures—a result that was shown not to be due to a minimum in the viscosity or a maximum in the ionising power of the mixed solvent, and was therefore attributed to a minimum in the size of the ionic complexes; cobalt chloride in a similar mixture of solvents gave rise to the interesting observation of a negative temperature-coefficient of conductivity, shading off through a zero value to the positive coefficient normally observed. The most important result of the work now described, apart from the confirmation of conclusions already arrived at, is the observation that potassium sulphocyanide has a much higher conductivity in acetone than in water; this cannot be due to an increased ionisation, and is therefore attributed to a greater ionic mobility depending on (1) the greater mobility of the solvent and (2) a smaller tendency to form ionic complexes containing large numbers of solvent molecules. In explanation of the decrease of viscosity produced by dissolving the sulphocyanide in water, it is pointed out that this result only occurs in salts of Cs, Rb, and K, and even then it is usually neutralised by the action of the anion in increasing the viscosity; it is suggested that the "negative viscosity" is associated with the high atomic volumes of the alkali metals and that it results from the excess of this atomic volume over the molecular volume of the solvent. T. M. L.

1724. *Conductivity and Viscosity of Tetraethylammonium Iodide in Water, Methyl Alcohol, Ethyl Alcohol, and Mixtures of these Solvents.* [*Mixed Solvents,* VIII.] **H. C. Jones** and **W. R. Veazey.** (Zeitschr. Phys. Chem. 62. 1. pp. 44–58, Feb. 25, 1908.)—The novel features of the present paper are (1) the use of Walden's typical electrolyte, $N(C_2H_5)_4I$, and (2) the introduction of nitrobenzene into the series of solvents. Maxima of conductivity were observed in mixtures of nitrobenzene and alcohol similar to those observed with potassium sulphocyanide in alcohol-acetone [see preceding Abstract], but as maxima were also observed in the fluidity curves, the changes of conductivity need not in this case be attributed to variations of ionic size. It is shown that viscosity-measurements are very largely influenced by traces of impurity. T. M. L.

1725. *Potential of a Hydrogen Electrode in Acid and Alkaline Solutions.* **C. L. A. Schmidt** and **C. P. Finger.** (Journ. Phys. Chem. 12. pp. 406–416, June, 1908.)—The work of other observers is confirmed, showing that either the compound NaH_2BO_3 or $NaBO_2$, or a mixture of the two, is the only one formed in solution to any appreciable extent on mixing boric acid and sodium hydroxide. As to which, or to what proportion of each, of the above really exists in solution and to what extent they are dissociated into Na, H_2BO_3, and BO_2 the present work gives no clue. The concentration of the hydrogen ions in a number of mixtures of sodium hydroxide and boric acid, each containing 0·25 gm.-atom of boron per litre, has been determined by measuring the potential of a hydrogen electrode in these solutions, and thus a series of readily reproducible standards for the colorimetric determination of acids and bases has been provided. T. S. P.

1726. *Gaseous Electrodes.* I. *Nitric Oxide.* **U. Grassi.** (N. Cimento, 15. pp. 467–480, June, 1908.)—The p.d. between NO and Hg measured by comparing a cell consisting of platinised Pt immersed partially in NO and partially in dilute acid, with an ordinary calomel (Hg, HgCl-KCl) cell, is 0·0577 log $H^{\cdot}$ + a constant. The system $H\cdot NO'_3$-NO has an e.m.f. of 0·80 volt, NO being positive to $H^{\cdot}$. In the presence of finely-divided platinum, NO and alkaline hydrates very readily form nitrites. W. H. Sɪ.

1727. *Review of the different Theories of Passivity and New Observations on the Passivity of Iron, Nickel, and Chromium.* **C. Fredenhagen.** (Zeitschr. Phys. Chem. 63. 1. pp. 1–47, June 9, 1908.)—The theories of the passivity of metals which assume (*a*) the existence of a film of oxide on the surface of the metal, (2) a change in valency or in the modification of the metal, are discussed by the author and rejected by him in favour of the view that the passive condition is due to a surface layer of gas. Thus passivity is really a reaction-velocity phenomenon, in which the velocity of reaction between the passive metal and oxygen plays the chief *rôle.* This theory is supported by polarisation experiments on Fe, Ni, and Cr electrodes immersed in sulphuric acid. The passive state is reached as soon as the oxygen polarisation extends uniformly over the whole surface of the electrode, and it disappears as soon as the reactions which use up oxygen overbalance those which produce oxygen. Even in the passive state the metals do not completely resist attack. The potential of the electrode at the point when it becomes active or passive is not well defined; it cannot be exactly reproduced, nor are the potentials at which a metal becomes active or passive in complete agreement. The potential at which activity or passivity sets in is affected by the strength of the sulphuric acid, and a slight increase in temperature favours the active condition very considerably. All this supports the view that the passive condition is a reaction-velocity phenomenon, depending on the rate at which the metal becomes charged with oxygen. [See Abstracts Nos. 169, 928 (1907).]

T. S. P.

1728. *Method for calculating Ionic Concentrations from Potential Measurements on Concentration Cells.* **W. K. Lewis.** (Zeitschr. Phys. Chem. 63. 2. pp. 171–176, June 16, 1908.)—The author gives a new method for calculating ionic concentrations from potential measurements on concentration cells. The chief advantage of the method is that the ionic concentrations of polyvalent ions can be ascertained without making any assumptions as to the steps in which dissociation takes place. The method is illustrated by calculating the ionic concentrations of the positive ions in solutions of silver nitrate, lead nitrate, and lead chlorate. The normal potential of lead against a solution of molar concentration with respect to Pb-ions is calculated to be 0·402.

T. S. P.

1729. *Nature of Surface Film on Aluminium, and the Aluminium-Magnesium Cell.* **H. T. Barnes** and **G. W. Shearer.** (Amer. Electrochem. Soc., Trans. 13. pp. 169–170; Discussion, pp. 170–172, 1908.)—The e.m.f. of the cell [see Abstract No. 1013 (1908)] depends upon the action of oxygen dissolved in the electrolyte on the surface of Al. Hydrogen peroxide is formed when the Al is anode and a film of $Al_2(OH)_6$ produced; when the Al is kathode, as in the normal galvanic cell, the film is decomposed. Immersed in pure water free of oxygen Al does not form H_2O_2; reference is made to G. Schulze [Abstract No. 2120 (1907)]. In the *discussion*, **C. F. Burgess** and **W. R. Whitney** agreed that Al rectifiers did not last long, because the Al corroded.

H. B.

1730. *Combustion of Air in the Electric Arc Flame.* II., III., IV. **A. Grau** and **F. Russ.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 321–351, 353–362, and pp. 363–371, March and April, 1908. From the Technolog. Gewerbemuseum, Wien.)—Further details of the researches noticed in Abstract No. 1251 (1907) [compare also Abstracts No. 1429 and 1969 (1907)]. In arcs burning in air between horizontal metallic electrodes, from 5 to 10 cm. apart, the arc potential is, at constant current, a linear function of the arc-length; the potentials decrease in the order Pt, Cu, Ni, Ag, Zn. When the electrodes are vertical the potentials are lower. When high-tension arcs of from 3 to 7 cm. length burn between vertical electrodes within water-cooled tubes of glass or quartz, and the resulting gases are withdrawn through capillary Pt tubes, the following observations are made: The potentials are higher owing to the contraction of the arc section and the cooling; the quotient (watts)/(volt-amperes) is fairly constant for different arc lengths, greater in oxygen (up to 0·90) than in air and in nitrogen (up to 0·85). The potential and energy absorbed at constant current increase with the oxygen percentage; the potential is, in oxygen and nitrogen and in their mixtures, a linear function of the velocity of the gas current. Within the pressure-limits 700 and 800 mm. of mercury pressure and potential vary proportionally; this influence is only noticeable in oxygen. The NO is best absorbed by sulphuric acid for analytical purposes. The NO-concentration is higher in the flame than close to it; it increases with the current intensity and the energy absorbed, but attains its upper limit already at about 0·1 amp. The NO-equilibrium is independent of the arc-length and the energy of consumption; in air it is attained at 5·5 per cent. by volume of NO, in a mixture of N and O in equal proportions at 6·6 per cent. The reaction is in accord with the law of chemical mass action, and seems to be essentially thermal; the calculated temperature of the high-tension arc is about 3,150° C. A yield of 500 kg. of HNO_3 per kw.-year at a concentration of 3 per cent. (by volume) of NO can be relied upon with arcs of 5 cm. H. B.

1731. *Electrolytic Formation of Selenic Acid from Lead Selenate.* **F. C. Mathers.** (Amer. Chem. Soc., Journ. 30. pp. 1374–1378, Sept., 1908.)—Selenic acid can be made from lead selenate by electrolysing a dilute solution of selenic acid in a Pt dish that serves as kathode, and upon which rests the lead selenate that is to be decomposed. Some reduction products of selenic acid are formed during the electrolysis, but these are insoluble and may be removed from the selenic acid solution by filtration. The best efficiency yield, amounting to 87 per cent., was obtained with a low current-density at the kathode, room temperature and a thin layer of lead selenate upon the kathode. The best current-yield, amounting to about 18 per cent., was obtained with a low current-density, a hot solution (85° C.), and a large amount of lead selenate upon the kathode. Only small amounts of selenic acid are formed from lead selenate in contact with the anode. T. S. P.

1732. *Rapid Electro-analysis of Metals.* II. *Antimony and Tin.* **H. J. S. Sand.** (Chem. Soc., Journ. 93. pp. 1572–1592, Aug., 1908.)—When a sulphuric acid solution or suspension of an antimony salt, in which the concentration of the acid is one part by volume to one part of water, and to which a small proportion of hydrazine sulphate has been added, is electrolysed in the author's apparatus at a temperature of 100° C. at an auxiliary potential of 0·65 volt, the Sb disappears from solution completely with a rapidity which is quite sufficient for the purposes of rapid electro-analysis. Quantitative results are thus obtained; there is no occlusion of non-electrolytes in the deposit, even in the presence of small amounts of chloride, and the high temperature prevents the formation of antimony hydride. In the quantitative deposition of tin the expedient adopted is to deposit first in the presence only of sulphuric and oxalic acids. The greater part of the tin thus appears in a beautiful silvery form, which corresponds with a high electrode potential, thus ensuring a high supertension. At the same time most of the oxalic acid is removed by oxidation at the anode. Hydrochloric acid and hydroxylamine hydrochloride are then added, by which the reduction of the stannic compound is greatly facilitated, and the last traces of tin are quickly deposited. The purpose of the hydroxylamine compound is to protect the anode from the nascent Cl which would otherwise be formed. Since Sn is not deposited below an auxiliary potential of 0·8 volt, whereas Sb can be deposited at 0·65 volt, quantitative separations of Sb from Sn can be carried out. For experimental details and a discussion of various theoretical points the original paper should be consulted. A description of an apparatus in which the rotating anode is surrounded by a diaphragm, and which is so made that the whole of the anolyte can be washed into the kathode compartment after most of the metal is deposited, is given. [See Abstract No. 982 (1907).] T. S. P.

1733. *Electrolytic Determination of Nitric Acid.* **O. L. Shinn.** (Amer. Chem. Soc., Journ. 30. pp. 1378–1381, Sept., 1908. Contribution from the John Harrison Lab. of Chemistry.)—The experiments of the author on the electrolytic reduction of nitric acid to ammonia at copper kathodes would seem to prove that the reduction takes place simultaneously with the precipitation of the copper, and that the slower the precipitation the more complete is the reduction. If all the copper is precipitated from solution before reduction is complete, the last traces of nitric acid will not be reduced by further passage of the current. If a rotating anode is used the rotation should be slow; the only advantage of rotation is a more adherent copper deposit. [See Abstract No. 3143 (1904).] T. S. P.

REFERENCES.

1734. *Microstructure of Hardened Supersaturated Steels.* **E. Hess.** (Iron and Steel Inst., Journ. 77. pp. 1–4, 1908.)—From a study of the microstructures of quenched high-carbon steels the author is led to uphold the view of Howe and others that austenite is stable above the critical range and is not completely prevented from transforming by quenching. F. R.

1735. *The P.T.X.-spacial Figure for a System of Two Components which are Miscible in the Solid or Liquid Crystalline State in all Proportions.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 165–168, Sept. 8, 1908.)

1736. *A Study of the Sulphur Anion and of Complex Sulphur Anions.* **J. Knox.** (Faraday Soc., Trans. 4. pp. 29–49; Discussion, pp. 49–50, July, 1908.)—A full account of the work on which a preliminary note was given in Abstract No. 570 (1907).

1737. *Thermodynamics of Liquid Chains.* **P. Henderson.** (Zeitschr. Phys. Chem. 63. 3. pp. 325–346, June 30, 1908.)—An extension of the work described in Abstract No. 1245 (1907).

1738. *Galvanic Cells with Solid Electrolytes.* **F. Haber.** (Ann. d. Physik, 26. 5. pp. 927–978, Aug. 25, 1908. From the Inst. f. physikal. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—This paper gives a summary, partly of results which have already been published in other journals, and partly of results which have not yet been published and are still being worked out. It is divided into the following sections: 1. Electrolysis of solid barium chloride and the theory of Daniell cells containing solid electrolytes. 2. Electrolysis of solid alkali salts. 3. Gas cells with solid electrolytes. 4. Electrolysis of porcelain. 5. Forces existing at the contact surfaces of (*a*) solid electrolytes, (*b*) solid salts and their saturated solutions. The paper is mainly theoretical, and is not suitable for short abstraction. T. S. P.

1739. *Orthobaric Volumes in relation to Pressure and Temperature.* **E. Haigh.** (Phil. Mag. 16. pp. 201–228, Aug., 1908.)—A theoretical paper in which the author brings forward a dual equation of state. The paper is not suitable for abstraction. F. J. B.